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An Annotated Bibliography of Environmental Research Conducted within the St. Louis River Estuary 1903-1982

prepared by: Philip DeVore

Lake Superior Basin Studies Center
214 Research Laboratory Building, Lower Campus
University of Minnesota, Duluth
Duluth, Minnesota 55812

January, 1983

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This annotated bibliography reviews manuscripts and publications for content, not for results. It is thus intended as a tool for individuals attempting to locate specific types of studies conducted within the St. Louis River estuary. Each review includes the study dates, specific analyses conducted, and the location within the estuary. All reviews are indexed by subject classes: benthos, birds, fish, fish contaminants, microbiology, physical processes, phytoplankton, sediment chemistry, vegetation, water quality, and zooplankton. This bibliography generally does not include secondary references such as many of the International Joint Commission and Great Lakes Commission summary reports.

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Preface

This report is an attempt to compile and review all of the physical, biological and chemical studies which have been conducted within the confines of the St. Louis River estuary. Although every effort has been made to locate obscure information, it is likely that some reports have been overlooked. If any reader knows of overlooked studies, a copy or information as to the location of a copy, would be greatly appreciated.

With increased interest in environmental assessment of impacts of future developments within the estuary, there is no doubt that many more studies such as those reviewed will continue to be conducted. In order to assist in the interpretation of this work, it is necessary to review available information of a comparable nature. The Lake Superior Basin Studies Center Reference Library has compiled most of the reports reviewed herein and interested users may review the reports at this facility. The Reference Library is located on the lower campus of the University of Minnesota, Duluth, (Room 217, Research Laboratory Building, 2205 East 5th Street) and any assistance can be obtained by telephoning, 218-726-8258. In order to maintain an up-to-date compilation, however, there must be a cooperative effort by all the agencies, institutions, and individuals involved. Therefore, unsolicited copies of any data or studies which might be available in the future would be appreciated and will be added to the Reference Library collection. The Library will in turn produce periodic summaries similar to this report and make these available to contributors and recipients of this original report.

Contents

	Page
Introduction	1
Harbor Bibliography	2
Subject Index to Reviews	61

Introduction

This annotated bibliography reviews manuscripts and publications for content, not for results. It is thus intended as a tool for individuals attempting to locate specific types of studies conducted within the St. Louis River estuary. Each review includes the study dates, specific analyses conducted, and the location within the estuary. All reviews are indexed by subject.

Subject matter from each reference has been identified within general classes in order to facilitate use and location of pertinent material. These subject classes are: benthos, birds, fish, fish contaminants, microbiology, physical processes, phytoplankton, sediment chemistry, vegetation, water quality, and zooplankton. Although these are basically self-explanatory, it might be noted the "microbiology" references are primarily coliform counts, "physical processes" includes largely grain size analyses, and "vegetation" is both aquatic and near-shore terrestrial.

This bibliography generally does not include secondary references such as many of the International Joint Commission and Great Lakes Commission summary reports.

An attempt was made to acquire or make copies of all reports. The location of reports as cited after each review is not comprehensive. Most are available at the Lake Superior Basin Studies Center Reference Library. Other sources or locations of specific documents are noted if they were found during the search process.

Harbor Bibliography

American Bechtel. 1974. Applicant's environmental impact report: refined products terminal, Superior, Wisconsin (Lakehead Pipeline Company, Inc.). American Bechtel, San Francisco, California. 300 pp.

This EIS compiles existing chemical and biological data for the lower estuarine area. The only original data contained within this report are chemical and physical analyses of four 1-meter cores adjacent to the Lakehead Pipeline dock. Analyses included particle size, volatile solids, oil and grease, COD, total-N, total-P, pH, As, Cd, Cu, Pb, Hg, Zn, and eight chlorinated hydrocarbons. Samples were collected in 1973.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 1)

Subjects: Physical processes, sediment chemistry

Estuary Location: Lakehead Pipeline dock

Bahnick, D.A. 1975. Chemical effects of red clays on western Lake Superior. **Center for Lake Superior Environmental Studies Publication** No. 35: 89 pp. (University of Wisconsin - Superior).

This report estimates the chemical loading to western Lake Superior attributed to red clay erosion. Sediment loading from Wisconsin streams, including the Nemadji River, were measured and leaching studies conducted under different conditions of oxygen, agitation, pH, and temperature. Effects of this leaching on dissolved solids, alkalinity, orthophosphate, total soluble P, nitrate, chloride, total Kjeldahl N, sodium, potassium, calcium, and magnesium in Lake Superior water were quantified.

Availability: Lake Superior Basin Studies Reference Library (G/ER18) and CLSES Library

Subjects: Water quality, physical processes

Estuary Location: General

Bahnick, D.A., J.W. Horton, and R.K. Roubal. 1970. Chemical water quality survey of the Superior Bay area. University of Wisconsin, Superior, Wisconsin. 8 pp.

Data is presented as the average of seven estuarine sites from the Superior entry to just above the Blatnik Bridge, several Nemadji Rivers sites, and Lake Superior sites.

Parameters analyzed were NH_3-N, NO_3-N, PO_4, COD, DO, dissolved solids, total solids, Na, Ca, Mg, Fe, Cu, conductivity, and alkalinity. All samples were collected in 1970.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 2)

Subject: Water quality

Estuary Location: Lower

Bahnick, D.A. and T. Markee. In Press. Metal characterization in fresh water sediments from the Duluth-Superior harbor. **Journal of Great Lakes Research.**

See Bahnick et. al. (1981) for basic content.

Availability: In press

Subjects: Water quality, sediment chemistry

Estuary Location: Lower estuary

Bahnick, D.A., N. Ahmad, and T. Markee. In Preparation. Transport of toxic substances into Lake Superior by suspended solids. Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, Wisconsin.

This project is being completed with a final report anticipated in early 1983. Project objectives include:

1) To assess the degree of contamination of particulate matter from the Duluth-Superior Harbor.

2) To estimate the inputs of particulate-transported microcontaminants from the harbor to Lake Superior.

3) To asses the magnitude of microcontaminant release from particulates to Lake Superior water

Availability: CLSES Library - manuscript in preparation

Subjects: Sediment chemistry, water quality

Estuary Location: Lower estuary

Bahnick, D.A., W.A. Swenson, T.P. Markee, D.J. Call, C.A. Anderson, and R.T. Morris. 1981. Development of bioassay procedures for defining pollution of harbor sediments - Part I. Center for Lake Superior Environmental Studies Publication No. 56. 186 pp. (University of Wisconsin, Superior,

Wisconsin) (Also available as NTIS Publication No. EPA 600/53-81-025)

Sediments from nine estuarine sites and one Lake Superior site were used in these bioassay procedures. Physical and chemical analyses of sediments collected at these sites during 1977 were pH, Eh, COD, NH_3-N, TKN, Total S, Total P, oil and grease, total phenols, organic N, total Hg, total solids, total volatile solids, % sand, % silt, % coarse clay, and % fine clay. Metal analyses of various phases of the sediments (exchangeable, reducible, organic, moderately reducible, and residual) were As, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, and Zn. Sediments were also analyzed for 15 chlorinated pesticides, seven PCB Arochlor mixtures, pentachlorophenol, and several PAH compounds. Overlying, interstitial, and elutriate waters were also analyzed for pH, total PCB's, H_2S, NH_3, TKN, COD, PO_4, suspended solids, chloride, organic N, As, Cd, Cr, Co, Cu, Ni, Fe, Pb, Mn, Se, Zn, and organic and inorganic Hg. Limited replication of the above tests was conducted in 1978.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 3). CLSES Library (7A/32)

Subjects: Water quality, sediment chemistry

Estuary Location: Lower half

Bennett, P. and M. Sydor. 1974. Use of ERTS in measurements of water quality in Lake Superior and the Duluth-Superior harbor. **Remote Sensing of Earth Resources Vol.** 3:85-92. (F. Shahrokhi, ed. University of Tennessee at Tullahoma.)

Discusses the use of ERTS images for measurement of suspended solids in Lake Superior and the estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 4)

Subjects: Physical processes, water quality

Estuary Location: Lower

Cartier, J.O. 1968. Walleyes in Maytime. **Outdoor Life.** May, 1968: 5 pp.

A tale of walleye fishing in the St. Louis River in the late 1960's.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 5)

Subject: Fish

Estuary Location: Upper

Chiu, S.Y. and A. Woodall. 1974. St. Louis River Basin Model. Midwest Research Institute, Kansas City, Missouri. 147 pp. (EPA Contract number 68-01-1853)

This report develops a mathematical model describing hydraulics and water quality of the lower St. Louis River. No original water quality measurements are presented in this document.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 28)

Subjects: Physical processes, water quality.

Estuary Locoation: Entire

City of Duluth. 1934. A winter survey of the St. Louis River, Bay, and Harbor. Duluth, Minnesota. 25 pp (Mimeographed).

DO, BOD, pH, alkalinity, hardness, total bacteria and coliform bacteria were monitored at seven estuarine stations from Fond du Lac to the Duluth entry. Sampling was conducted from January to May. Daily river discharge estimates are also presented.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 6)

Subjects: Water quality, microbiology

Estuary Location: Entire

City of Duluth. 1946-1972. St. Louis River estuary water quality data. Duluth, Minnesota. 500 pp (Mimeographed).

Estuarine water quality data from 1946 through 1972. Five stations were monitored at weekly intervals from April to November. From 1946 to 1965 measured parameters were temperature, pH, total bacteria, fecal coliform, dissolved oxygen, and BOD. Beginning in 1966, turbidity, color, total and dissolved solids, COD, CO_2, SO_4, Cl, hardness, alkalinity, and PO_4 were measured semi-weekly. Alkyl benzene sulfonate was added in 1967. During 1969 a fairly intensive bacteriological study was conducted in late summer at a number of stations. Counts were total count, total coliform, fecal coliform, enterococcus, staph, and sal. shig.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 7)

Subjects: Water quality, microbiology

Estuary Location: Entire

Clapper, R.T., Jr., D. Smith, K. Stortz, and M. Sydor. 1975. Ice growth studies in Duluth-Superior Harbor 1974-75. University of Minnesota, Duluth, Minnesota. 72 pp. (Mimeographed).

Discusses ice growth in the Duluth-Superior Harbor. Considers water currents, temperatures, snow cover, convective heat from the bottom, and snow reflectivity (albedo). Ice-growth curves for Duluth Harbor, west gate basin, Duluth entry, Superior front channel, Allouez Bay, Spirit Lake, Minnesota channel, and St. Louis Bay are presented. Detailed water temperature data for January - March is tabulated for these sites. One-time velocity measurements at 160 points from Fond du Lac to the entries are tabulated. Figures are presented for typical daily winter and summer water current and water level cycles as affected by the eight hour seiche cycle.

Availability: Lake Superior Basin Studies Center Reference Library (H/G29)

Subject: Physical processes

Estuary Location: General

Croft, A. 1976. A study of benthic macroinvertebrates near a municipal sewage outfall. University of Minnesota, Duluth, Minnesota. 15 pp. (Student paper, Mimeographed)

A quantitative and qualitative study of benthos conducted by a UMD student at the sewage outfall before the new WLSSD plant went on line.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 8)

Subject: Benthos

Estuary Location: 21st Avenue Slip

Crosby, J. 1980. A quantitative roving creel census and angler profile of the 1979-1980 winter fishing season on the St. Louis Estuary. Minnesota Department of Natural Resources, Division of Fish and Wildlife, St. Paul, Minnesota. 15 pp. (Fish Management Report No. 23.)

Results of a 1979-1980 winter creel census are reported. Information includes total effort, catch per unit effort,

and catch composition. Late winter vertical oxygen profiles from a number of sites are also presented.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 70)

Subjects: Fish, water quality

Estuary Location: Entire

Dabydeen, S. and R.G. Koch. 1977. Vegetation and floristics of a sand spoil deposit: Barker's Island in Superior Harbor, Douglas County, Wisconsin. **The Michigan Botanist** 16: 39-46.

A taxonomic examination of the terrestrial vegetation of Barker's Island.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 9)

Subject: Vegetation

Estuary Location: Barker's Island

Davis, T. and R. M. Erwin. In preparation. Potential impacts of extended winter navigation upon migratory birds of the upper United States Great Lakes. United States Fish and Wildlife Service, (Office of Biological Services).

Projects incorporated within this report were oriented toward assessing how ship traffic and related disturbances affected bird distribution, movement, and habitat utilization. Also contained within this report is a study of marsh sites near and away from ship traffic to determine any impacts on vegetation characteristics.

Availability: In preparation

Subjects: Vegetation, birds

Estuary Location: Entire

Davis, T., G. Niemi, J. Kotar, and P. Hofslund. 1978. Assessment of habitat types and bird populations in the lower St. Louis River, Phase II. University of Minnesota, Duluth, Minnesota. 95 pp.

A continuation of the study begun in 1976 (Niemi, et al, 1977). Phase II essentially duplicated the techniques of the previous year but studied the area from the Arrowhead Bride to Commonwealth Avenue (the Boy Scout boat landing).

Availability: Lake Superior Basin Studies Center Reference Library (W/H15)

Subjects: Birds, vegetation

Estuary Location: Arrowhead Bridge to Commonwealth Avenue

DeVore, P.W. 1977. Fishery assessment for the Douglas County submerged lands between ORBA and Wisconsin Grassy Point. **Center for Lake Superior Environmental Studies Publication** No. 45: 10 pp. (University of Wisconsin-Superior)

This study assesses and compares fish use of several embayments in the lower estuary. Data is tabulated for three years of gill net, fyke net, seine, and electrofishing catches.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 10)

Subject: Fish

Estuary Location: Minnesota Point to Billings Park

DeVore, P.W. 1978. Fishery Resources of the Superior-Duluth estuary. **Center for Lake Superior Environmental Studies Publication** No. 54: 80 pp. (University of Wisconsin-Superior)

This report compiles all fishery data for the estuary which existed prior to 1978. Site specific fish densities or relative catches are presented for major species. Also included is information on growth rates, critical habitat areas, distribution of fish in relation to physical habitat features, and a creel census.

Availability: Lake Superior Basin Studies Center Reference Library (F/R9), CLSES Library

Subject: Fish

Estuary Location: Entire

DeVore, P.W. and J.R. Hargis. 1982. Spatial and temporal patterns of habitat utilization by young-of-year walleye (**Stizostedion v. vitreum**) in the St. Louis River estuary. **Minnesota Sea Grant Program Research Report** No. 6: 16 pp.

This report is a summary of a one-year program development project. Although a very poor walleye year class prevented realization of the objectives indicated by the title, the report does give estimated densities of young-of-year and

forage size fish both in-shore and off-shore throughout the estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 11), Minnesota Sea Grant Program

Subject: Fish

Estuary Location: Entire

Dole, R. B., and F. F. Wesbrook. 1907. The quality of surface waters in Minnesota. United States Geological Survey, Washington, D.C. 14 pp. (Water-Supply and Irrigation Paper #193, Series L, Quality of Water, 19)

The general character of the St. Louis River watershed from Lake Superior to its headwaters is discussed. Source of municipal waste are identified. Water quality samples were taken during 1903 and 1904 at 10 sites from Scanlon and upriver. Monitored parameters were color, odor, turbidity, chlorides, sulphate, alkalinity, hardness, iron, total residue, soluble residue, NH_3 (free and albuminoid), NO_2, NO_3, and bacteria.

Availability: St. Louis River excerpt only - Lake Superior Basin Studies Center Reference Library (SLR 12)

Subjects: Water quality, microbiology

Estuary Location: All sites upstream from estuary

Doucette, W.J. 1980. Impact of a new point source of chloroorganics on the St. Louis River. University of Minnesota, Duluth, Minnesota. 68 pp. (M.S. Thesis)

This project monitored chloroform levels in the St. Louis River as a potential indicator of total chloroorganic pollution, determined the effect of effluent from the Western Lake Superior Sanitary District treatment plant on chloroorganics in fish fillets, and identified various chloroorganics in effluents from the Potlatch Paper Company and the WLSSD treatment facility.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 13), CLSES Library (9/11)

Subjects: Water quality, fish contaminants

Estuary Location: Entire

Food and Drug Administration. 1980. Report of sample analysis. Food and Drug Administration, Minneapolis, Minnesota. 1 pp.

(Mimeographed)

One carp from the lower St. Louis River was analyzed for PCB's. The 5.43 ppm level exceeded FDA guidelines of 5 ppm.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 97)

Subject: Fish contaminants

Estuary Location: --

Harris, J.T. and S.W. Matteson. 1975. Gulls and terns as indicators of man's impact on Lake Superior. **University of Wisconsin Sea Grant Program Report** No. 227. 45 pp.

This study describes distribution, numbers, and nesting success of herring gulls, ring-billed gulls, common terns, and piping plover along Wisconsin's Lake Superior shoreline and both Minnesota and Wisconsin shores of the St. Louis River estuary. It also briefly discusses factors affecting success and failures of breeding pairs or colonies. The survey was conducted during the summer of 1974.

Availability: Lake Superior Basin Studies Reference Library (W/HI2), CLSES Library (7B/9)

Subject: Birds

Estuary Location: Entire

Hassinger, R.L. 1967. Preliminary report on environmental and fish habitat conditions of the lower St. Louis River and its potential for anadromous salmonids. Minnesota Department of Natural Resources, St. Paul, Minnesota. 7 pp.

The general character of the lower river is briefly reviewed. Fish kills during the 1950's and the general water quality problems are discussed. Total alkalinity, SO_4, Cl, total-N, dissolved solids, Fe, and total P are summarized from various sources between 1904 and 1962. Data is presented for two gill net sets below the Fond du Lac dam in 1967.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 14)

Subjects: Fish, water quality

Estuary Location: Upper

Helmke, P.A., R.D. Koons, and I.K. Iskander. 1976. Final report,

an assessment of the environmental effects of dredged material disposal in Lake Superior, Volume 5, trace element study Duluth-Superior and Keweenaw study areas. Marine Studies Center, Institute of Environmental Studies, University of Wisconsin, Madison, Wisconsin. 148 pp.

Forty sediment samples were collected from the lower estuary and near-shore Lake Superior (as well as more off-shore areas). Trace elements (As, Ba, Ce, Co, Cr, Cs, Cu, Eu, Fe, Ga, Hf, Hg, K, La, Lu, Na, Rb, Sc, Sm, Tb, Yb, and Zn) were analyzed in total sediment, the silt plus clay fraction, and the clay fraction. Limited analyses were conducted on open Lake Superior water and water agitated with harbor sediments. The flesh, liver, and contents of the alimentary canal from sculpins, suckers, and burbot from near-shore Lake-Superior were analyzed for the above elements as were samples of the amphipod, **Pontoporeia**. All samples were collected between October, 1973 and June, 1975.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 15), CLSES Library (7B/3D)

Subjects: Sediment chemistry, fish contaminants

Estuary Location: Lower estuary including 21st Avenue slip

Horton, J.W., A.B. Dickas, and P.H. Ruez. 1974. A study of the pollution levels and depths within subsurface cores collected during preliminary investigations for the proposed Arrowhead Bridge. Center for Lake Superior Environmental Studies, University of Wisconsin, Superior, Wisconsin. 33 pp.

Physical and chemical parameters of sediments from bore holes in the vicinity of the new Arrowhead Bridge are examined. Five bore holes were sampled at 5 to 8 depth intervals ranging from 2 to 122 feet. At each depth samples were analyzed for particle size, Cd, Pb, Hg, Ni, Zn, total P, total Kjeldahl-N, total solids, volatile solids, and COD. Samples were collected in 1974.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 16)

Subjects: Physical processes, sediment chemistry

Estuary Location: New Arrowhead Bridge

Horton, J. W. and D. F. Parr. 1976. Chemical and physical analyses of selected highway construction materials in Douglas County, Wisconsin. **Center for Lake Superior Environmental Studies Publication** No. 42: 55 pp.

Analysis of soil and dredge spoil suitability as fill material for the Arrowhead Bridge. Included are analyses of soils from areas adjacent to but not within the estuary. Analyses included grain size, chemical oxygen demand, heavy metals (cadmium, chromium, copper, lead, nickel, and zinc), nitrate nitrogen, oil and grease, total Kjeldahl nitrogen, total solids, and volatile solids.

Availability: Wisconsin DOT, CLSES Library, Lake Superior Basin Studies Center Reference Library (T/RP4)

Subjects: Sediment chemistry, physical processes

Estuary Location: --

International Joint Commission. 1977. The waters of Lake Huron and Lake Superior - Volume III, Part A Lake Superior. International Joint Commission, Windsor, Ontario. 242 pp.

This document summarizes the results of many project reports and outlines Lake Superior's physical, chemical, and biological characteristics. Brief summaries are also presented on sediment chemistry, physical parameters, microbiology, phytoplankton, chlorophyll, zooplankton, and benthos.

Availability: Lake Superior Basin Studies Center Reference Library (H/WQ17e) and most local libraries.

Subjects: Water quality, sediment chemistry, microbiology, phytoplankton, zooplankton, benthos

Estuary location: General

Jordan, T.F., K.R. Stortz, and M. Sydor. 1981. Resonant oscillation in the Duluth-Superior Harbor. **Limnology and Oceanography** 26(1): 187-191.

This paper discusses Helmholtz resonance periods within the estuary. It identifies the length of time for the periods and presents data for typical 48 hour water fluctuations.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 17)

Subject: Physical processes

Estuary Location: Entire

Kaups, Matti. 1978. North shore commercial fishing, 1849-1870. **Minnesota History** 46(2): 42-58.

An historical account of Minnesota's north shore fishery including relative use, importance, and composition of the fishery in the St. Louis River estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 18)

Subject: Fish

Estuary Location: Entire

Kingston, J. 1982. Diatom analyses of estuarine sediment samples. (Unpublished)

Projects in process include enumeration and identification of diatoms from a 375 cm sediment core and similar treatment of 12 sediment samples collected in a series from the lake entry to above Fond du Lac. Diatom assemblages are also being considered along near shore Lake Superior and from a 475 cm core from near Silver Bay.

Availability: Unpublished

Subject: Phytoplankton

Estuary Location: Entire

Koch, R.G., R.D. Morden, P.W. DeVore, L.M. Koch, and A.B. Dickas. 1976. Environmental inventory of the lower St. Louis River covering proposed improvements to Duluth-Superior Harbor, Minnesota and Wisconsin. Final Report. **Center for Lake Superior Environmental Studies Publication** No. 34: 67 pp. (University of Wisconsin-Superior).

Terrestrial, marsh, and submerged vegetation, adult fish populations, and benthic communities are examined in five embayments between the Blatnik and Arrowhead Bridges, and one site at the mouth of Pokegama Bay. The five embayments were being considered as dredge spoil sites. Included are a species list for vegetation, species, size, and catch per unit effort (gill nets) for fish, and density and species list for benthos. Samples were collected during two periods (mid-summer and early fall) in 1975.

Availability: Lake Superior Basin Studies Center Reference Library, (SLR 19) CLSES Library (7A/11A)

Subjects: Vegetation, fish, benthos

Estuary Location: Embayments between the Blatnik and Arrowhead Bridge

Koch, R.G. 1981. Vegetation and floristics of Allouez Bay, Superior, Wisconsin. Biology Department, University of Wisconsin, Superior, Wisconsin. 36 pp.

This report reviews the history and present status of the Allouez Bay wetlands. Plant species composition and relative importance are identified. Seasonal production of certain species is estimated. A limited study of bird use is conducted. All work was conducted during 1980.

Availability: Lake Superior Basin Studies Center Reference Library, (SLR 20) University of Wisconsin-Superior, Biology Dept.

Subjects: Vegetation, birds

Estuary Location: Allouez Bay

Koch, R.G., P.W. Lukens, L. Bruederle, P. Olson. 1980. Wisconsin Point - A review of the fauna and flora with management suggestions. Department of Biology, University of Wisconsin, Superior, Wisconsin. 34 pp.

As indicated by the title, this report contains lists of flora and fauna. Lists of mammals, birds, amphibians, and reptiles were compiled through literature reviews. The list of vascular flora was compiled through literature review and an intensive survey.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 21). University of Wisconsin-Superior, Department of Biology

Subjects: Vegetation, birds

Estuary Location: Wisconsin Point

Lakela, O. 1939. A floristic study of a developing plant community on Minnesota Point, Minnesota. **Ecology** 20(4): 54-552.

Discusses the development of the vegetational community in a new dredge spoil deposition area. Observations took place over a four-year period (1935-1938).

Availability: Lake Superior Basin Studies Center Reference Library (SLR 22)

Subject: Vegetation

Estuary Location: Minnesota Point

Long, D., R. Wilson, and D.P. Poe. 1978. Evaluation of the use of a silt curtain during dredging and disposal in the Duluth-Superior Harbor. Lake Superior Basin Studies Center, University of Minnesota, Duluth, Minnesota. 22 pp.

This project monitored the effectiveness of a silt curtain on restricting turbidity and suspended solids. Sampling transects were set up within, immediately outside, and 100 and 400 feet outside the curtain. Timed samples were taken during and after disposal both with and without the curtain in place.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 23)

Subject: Water quality

Estuary Location: --

Lounsbury, S., T. Davis, and G. Niemi, 1981. An assessment of impact of Arrowhead Bridge construction on a ring-billed gull colony. Lake Superior Basin Studies Center, University of Minnesota, Duluth, Minnesota. 34 pp.

Documentation of the impact of bridge-related construction on the gull colony of Minnesota Power's Hibbard plant. Behavior, as well as nesting activity, clutch size, hatching success, and fledgling survival are noted. The status of the ring-billed gull on an estuarine-wide basis is also assessed.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 24)

Subject: Birds

Estuary Location: Lower estuary

Loy, W.G. 1963. The formation of the Duluth-Superior Harbor. **Procedings of the Minnesota Academy of Science** 31(1):28-35.

Discusses the processes involved in the formation of Rice's and Conner's Points and Minnesota and Wisconsin Points.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 25)

Subject: Physical processes

Estuary Location: Lower harbor

Magnuson, J.J., A.M. Forbes, and R.J. Hall. 1976. Final Report, an assessment of the environmental effects of dredged

material disposal in Lake Superior, Volume 3, biological studies, Duluth-Superior and Keweenaw study areas. Marine Studies, Center, Institute for Environmental Studies, University of Wisconsin, Madison, Wisconsin. 173 pp.

Bioassays were conducted on **Pontoporeia** and sculpins collected from Lake Superior off Minnesota Point using "prepared" sediments to simulate Zn and Hg dredge spoil concentrations. Benthic invertebrates were sampled at 8 stations in the lower estuary (including 21st Avenue slip). Benthic analyses are presented as average number/m^2 and four broad taxonomic categories. Field samples were collected in 1973 and 1974. Observations were also made of shorebirds and gulls and terns. Behavior, abundance, and preferred substrates were noted.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 26) CLSES Library (7B/3B)

Subjects: Sediment chemistry, benthos, birds

Estuary Location: Lower estuary (including 21st Avenue slip)

Maschwitz, D.E., R.J. Wedlund, and H.J. Wiegner. 1976. Minnesota, Lake Superior near shore water quality study. Minnesota Pollution Control Agency, Roseville, Minnesota. 180 pp. (Surface and Groundwaters' Section)

This study was part of a program intended to assess the impact of tributary streams on near-shore Lake Superior. The St. Louis River estuary was one of three Minnesota tributaries studied. Four sites in the harbor (inside Minnesota Point) and four Lake Superior sites were monitored for coliform bacteria, chlorophyll a, phytoplankton, periphyton, zooplankton, benthos (grab samples and artificial substrate), and water chemistry. Samples were collected during the fall of 1974 and spring of 1975. Taxonomy of plant and animal groups was generally to the genus or species level. Physical and chemical measures of water quality were: secchi disk, dissolved oxygen, BOD, total solids, suspended solids, turbidity, alkalinity, total hardness, pH, specific conductance, total P, soluble P, NH_3-N, organic-N, nitrite-N, nitrate-N, total N, Na, Cl, K, Ca, As, Si, Se, Hg, Pb, Cr, gross alpha, gross beta, tritium, color, phenolic compounds, PCB, and chlorinated hydrocarbon pesticide (16 types).

Availability: Minnesota Pollution Control Agency, Lake Superior Basin Studies Center Reference Library (L/G4)

Subjects: Microbiology, phytoplankton, zooplankton, benthos, water quality

McElroy J.C. and F. Porcella 1968 St Louis Dispersion Study, Vol. II - Analysis, AP-53. EPA, Research Triangle Park N.C.

Location: Lower estuary, near-shore Lake Superior

McElroy, A.D. and S.Y. Chin. 1974. Water pollution investigation: Duluth-Superior area. Midwest Research Institute, Kansas City, Missouri. 99 pp. (EPA, Region V, Contract number 68-01-1593).

This report basically gathers data for development of a water quality model for the St. Louis River system and for projection of water quality after compliance of discharges to the 1972 Amendments to the Water Quality Act. The model is developed in another document (Midwest Research Institute, 1974). The only original data presented here are for two weeks during November and December, 1973. Ten estuarine stations (Oliver and Fond du Lac) as well as 8 upriver stations were monitored one to three times per day for DO, pH, BOD, fecal coliform, total coliform, NH_3-N, total Kjeldahl-N, NO_3-N, NO_2-N, total-P, available-P, sulfide, sulfate, total dissolved solids, and chlorophyll.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 27)

Subjects: Water quality, microbiology, phytoplankton

Estuary Location: Entire

Minnesota Department of Natural Resources. 1971. St. Louis River: bay area in vicinity of Duluth. Minnesota Department of Natural Resources, St. Paul, Minnesota. 3 pp. (Mimeographed)

Results of a visual survey of the river from Hwy. 23 to the Arrowhead Bridge. Mostly visual reconnaisana of water quality, water depths, and vegetation. The intent was to determine general conditions for waterfowl and furbearers.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 29)

Subjects: Vegetation, water quality

Estuary Location: Upper

Minnesota Department of Natural Resources. 1978. PCB's in white suckers from the St. Louis River at Cloquet and Brookston. Minnesota Department of Natural Resources, St. Paul, Minnesota. 1 pp. (Office Memorandum)

Two composite samples of 25 and 9 suckers were analyzed for PCB's. The levels found were 0.35 and 0.13 ppm at Cloquet and Brookston respectively.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 98)

Subject: Fish contaminants

Estuary Location:

Minnesota Department of Natural Resources. 1980a. Biological surveys, Duluth-Superior Harbor. Minnesota Department of Natural Resources, St. Paul, Minnesota. 17 pp. (Mimeographed)

This correspondance contains a series of three departmental memos dealing with vegetation, fish, and benthos, primarily in the proposed dredge spoil sites between the Arrowhead and Blatnik bridges. Vegetation was sampled in June and August, 1980. Data presented is qualitative and semi-quantitative (relative density). Fishery data is an electrofishing survey conducted at sites throughout the estuary. Data is presented by species as catch per unit time. Benthos data is presented as broad taxonomic groups and quantified as total volume of each group. All samples were collected in 1980.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 30)

Subjects: Vegetation, fish, benthos

Estuary Location: Primarily Minnesota bays between the Arrowhead and Blatnik bridges.

Minnesota Department of Natural Resources. 1980b. Summary of the electrofishing survey of Duluth harbor. Minnesota Department of Natural Resources, Duluth, Minnesota. 5 pp. (Mimeographed)

Summarizes electrofishing catches at 25 sites along the Minnesota shoreline of the St. Louis River estuary from Minnesota Point to Commonwealth Avenue.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 31)

Subject: Fish

Estuary Location: Entire

Minnesota Department of Public Health. 1961. Report on investigation of pollution of the St. Louis River, St. Louis Bay, and Superior Bay. Minnesota Department of Health. Minneapolis, Minnesota. 41 pp. (plus tables and appendices)

This study was conducted in response to concerns over use of public beaches within the estuary. It identifies major municipal and industrial pollution sources and type of pollutants. Coliform counts were made at 35 locations within the estuary with samples at up to eight sites in cross-sections across the estuary. Additional determinations were temperature, pH, DO, BOD total and suspended solids, alkalinity, chlorides, total-P, TKN, NO_3-N, turbidity, and color. Benthos and phytoplankton were examined at eight sites from Fond du Lac to the Blatnik Bridge. Two to five samples were taken in transects at each site. Quantitative and qualitative analyses are presented. All samples were collected in June and August of 1961.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 32)

Subjects: Benthos, phytoplankton, microbiology, water quality

Estuary Location: Entire

Minnesota Department of Public Health. 1982. Minnesota Health Department advisory guidelines for fish consumption in Minnesota. Minnesota Health Department, Minneapolis, Minnesota. 1 pp. (Mimeographed)

A one-page summary of the maximum recommended number of fish meals per month in Minnesota waters including the St. Louis River and estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 33)

Subject: Fish contaminants

Estuary Location: Entire

Minnesota Pollution Control Agency. 1969. Report on water quality and sources of wastes in the Lake Superior Basin. Division of Water Quality. Minnesota Pollution Control Agency, Roseville, Minnesota. 6 pp.

The section of the report located examines water quality in the estuary and near shore Lake Superior. Six estuarine sites were sampled in January and thirteen Lake Superior sites in July, 1966. Measured parameters were total coliform, fecal coliform, total solids, total volatile matter, suspended solids, turbidity, color, hardness, pH, alkalinity, BOD, chlorides, DO, total P, NH_3-N, organic-N, NO_2-N, NO_3-N, and surfactants.

Availability: Estuarine excerpt only - Lake Superior Basin

Studies Center Reference Library (SLR 34)

Subjects: Microbiology, water quality

Estuary Location: Entire

Minnesota Pollution Control Agency. 1971. Water quality monitoring stations: Lake Superior Basin. Minnesota Pollution Control Agency, Roseville, Minnesota. 14 pp. (Mimeographed)

This collection of mimeos includes water quality data from the Fond du Lac sampling station. Analyses are as often as once monthly from 1958 to 1970. Parameters monitored varied over time but include (at the most) temperature, total and fecal coliform, total and suspended solids, turbidity, color, hardness, alkalinity, pH, DO, BOD, Total-P, NH_3-N, organic-N, NO_2-N, NO_3-N, Ca, Cd, Ni, K, SO_4, F, As, Ag, Si, Se, SO_3, DDT, Mg, Ca, Pb, Fe, Mn, beta, alpha, fecal strep, Cr, Cn, oil, and Hg.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 35)

Subject: Water quality

Estuary Location: Fond du Lac

Minnesota Pollution Control Agency. 1973. Report on waste disposal at United States Steel Company, Coke Plant, Duluth. Minnesota Pollution Control Agency, Division of Water Quality, Roseville, Minnesota. 24 pp.

Water quality, sediment chemistry, and benthos were examined to determine the impact of the coke plant on the Spirit Lake area of the estuary. Measured water quality parameters were coliform bacteria, total and volatile solids, suspended solids, turbidity, alkalinity, pH, Cl, DO, BOD, total-P, NH_3-N, organic-N, NO_2-N, NO_3-N, Cu, Cd, Ni, Zn, Hg, Cr, cyanides, phenols, sulphates, Pb, As, Se, sulfides, and oil. Sediments were monitored for Cl, total-P, Cu, Cd, Ni, Mn, Hg, Zn, Pb, Fe, cyanide, phenols, sulphate, As, Se, and sulfide. Quantitative and qualitative data is presented for benthos.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 36)

Subjects: Water quality, microbiology, sediment chemistry, benthos

Estuary Location: Spirit Lake

Minnesota Pollution Control Agency. 1975. Investigation of the United States Army Corps of Engineers dredging operation in the Duluth Harbor Basin, Duluth-Superior Harbor. Division of Water Quality, Minnesota Pollution Control Agency, Roseville, Minnesota. 24 pp.

An investigation designed to identify the impact of dredging operations on water quality at the site of removal and disposal. In this case disposal was in Lake Superior along Minnesota Point. Samples were taken three months prior to the dredging operation and at points at and surrounding the dredge and disposal operations. Parameters monitored were total and suspended solids, turbidity, color, pH, total-P, soluble-P, NH_3-N, organic-N, NO_2-N, NO_3-N, specific conductance, Cr, Fe, Pb, Hg, Cu, Cd, Ni, Zn, fecal coliform, and total coliform. The study was conducted in July, 1975.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 94)

Subjects: Water quality, microbiology

Estuary Location: Duluth harbor basin

Minnesota Pollution Control Agency. 1977. Study of Minnesota's tributaries to Lake Superior. Minnesota Pollution Control Agency, Roseville, Minnesota. 229 pp. (United States Environmental Protection Agency Contract number 68-01-1878)

This study monitored water quality from municipal discharges and Minnesota tributaries in support of the IJC - Upper Great Lakes Reference Group. St. Louis River estuary stations were established at Oliver and under Blatnik Bridge. Parameters monitored monthly were temperature, total and fecal coliform, total solids, suspended solids, dissolved solids, turbidity, total hardness, alkalinity, pH, DO, BOD, total-P, NH_3-N, NO_2-N, organic N, total N, conductivity, Cl, SO_4, F, Ca, Cd, Ni, Zn, Pb, Fe, Mn, Ca, Na, K, phenols, silica, and discharge. Parameters monitored three times per year were Sr-90, Ra-226, DDT, oil and grease cyanide, COD, total organic C, As, Ba, Cr, Hg, Se, Mg, beta, and beta-T. Sampling was conducted from September, 1973 through June, 1975.

Availability: Lake Superior Basin Studies Center Reference Library, (SLR 37) Data available on STORET, Primary STORET Nos. 014 (Oliver Station) and 030 (Blatnik Bridge)

Subjects: Water quality, microbiology

Estuary Location: Oliver, Blatnik bridge

Minnesota Pollution Control Agency. 1979. Biological monitoring

program, a compilation of biological data for 1976 and 1977. Minnesota Pollution Control Agency, Director of Water Quality, Surface and Groundwaters Section. Roseville, Minnesota. 98 pp.

This publication compiles macroinvertebrate sampling information from a number of Minnesota lakes and streams including one site under the Blatnik Bridge. Results are presented for one ponar grab sample in 1976 and two Hester-Dendy multiple samplers in 1977.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 38)

Subjects: Benthos

Estuary Location: Blatnik Bridge

Minnesota Pollution Control Agency 1980. STORET retrieval:fish contaminants. Minnesota Pollution Control Agency, Roseville, Minnesota. 8 pp.

An August, 1982 STORET retrieval containing St. Louis River fish contaminant analyses for 1978, 1979, and 1980. Northern pike, walleye, white suckers, and redhorse are analyzed for PCB Arochlors 1242, 1016, 1254, 1260, and total, two forms of DDD, DDE, and DDT, dieldrin, aldrin, endrin, chlordane, methoxychlor, PCP, As, Cd, Cr, Hg, Pb, and Cu. All compounds were not analyzed in all years.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 39) STORET system

Subject: Fish contaminants

Estuary Location: Entire

Minnesota Pollution Control Agency. 1981. Biological monitoring program: Minnesota streams, an assessment of biological data for 1977, 1978, and 1979. Division of Water Quality, Monitoring and Analysis Section, Minnesota Pollution Control Agency, Roseville, Minnesota. 88 pp.

This report summarizes statewide biological monitoring in selected river basins as initially reported in MPCA, 1979. Monitoring was conducted solely with Hester-Dendy type multiplate samplers. The only reported site for the estuary is adjacent to the Blatnik Bridge. Qualitative (generic level of identification) and quantitative data is presented.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 40)

Subject: Benthos

Estuary Location: Blatnik Bridge

Minnesota Power and Light Company. 1977. Report on 316(b) entrainment impingement studies performed at Minnesota Power and Light Company's M. L. Hibbard Steam Electric Station. Minnesota Power and Light Company, Environmental Affairs Department, Duluth, Minnesota. 206 pp.

This study includes identification and enumeration of organisms impinged on screens at the cooling water intake as well as organisms entrained and passed through the cooling system. Classes of organisms considered were juvenile and adult fish, icthyoplankton, zooplankton, phytoplankton, and macroinvertebrates. Analyses were also conducted within the source water body, the bay immediately south of the power plant, to determine species composition and abundance of all of these groups. Water quality components determined concurrently were dissolved oxygen, temperature, turbidity, pH, total residual chlorine, total suspended solids, and specific conductance. All sampling was conducted between January and December, 1975.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 41)

Subjects: Phytoplankton, zooplankton, benthos, fish, water quality

Estuary Location: Bays adjacent of MP & L's Hibbard plant

Minnesota State Board of Health. 1929. Investigation of the pollution of the St. Louis River below the junction of the Little Swan, of St. Louis Bay, and Superior Bay, and of Lake Superior adjacent to the cities of Duluth and Superior. Minnesota State Board of Health, St. Paul, Minnesota. 100 pp. (in collaboration with the Minnesota Commission of Game and Fish, St. Paul, Minnesota, and the Wisconsin State Board of Health, Madison, Wisconsin)

Specific polluters and size of treatment facilities of towns along the St. Louis River and Estuary are identified. It also determines the effect of estuarine discharge on water quality in Lake Superior. Water quality parameters monitored at two week intervals from May 1928 to January 1929 and March to September 1929 were turbidity, color, solids, pH, alkalinity, total hardness, oxygen consumed, DO, phenol, and BOD. Total bacteria and Coli aerogenes were also determined. Qualitative and quantitative data is presented for benthic samples from the St. Louis River and estuary and near shore Lake Superior.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 42)

Subjects: Water quality, microbiology, benthos

Estuary Location: Entire

Minnesota State Board of Health. 1948. Report of the follow-up survey of the pollution of the St. Louis River. Minnesota State Board of Health, St. Paul, Minnesota. 74 pp.

This study repeats that which was conducted in 1928-1929 (Minnesota State Board of Health, 1929). Sampling sites and measured parameters were comparable. The only addition was a quantitative and qualitative study of phytoplankton.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 43)

Subjects: Water quality, microbiology, phytoplankton, benthos

Estuary Location: Entire

Moyle, J.B. and J. L. Skrypeck, 1972. Concentrations of some organochlorine insecticides and the PCB, Arochlor 1254, in flesh and brain tissue of fish collected in 1969. **Minnesota Department of Natural Resources Special Publication No.** 95: 24 pp.

This report contains analyses of DDT, DDE, aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, methoxochlor, and PCB arochlor 1254 in three suckers from the estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 44)

Subject: Fish contaminants

Estuary Location: --

Murray, J. 1980. River on the Rebound. **Minnesota Fins and Feathers.** May, 1980:86-93

A popular account of the recovered walleye fishery in the St. Louis River.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 99)

Subject: Fish

Estuary Location: Entire

National Biocentric, Inc. 1973a. Environmental impact assessment for Duluth-Superior Harbor. United States Army Engineer District, St. Paul, Minnesota [under contract DACW-37-73-C-0074]. 271 pp. (plus Appendices-separate volume)

The project purpose was to assess the environmental impacts associated with harbor maintenance activities. Eight zones were examined. All zones were in the lower estuary with six below the Blatnik Bridge, one in the 21st Avenue slip (Duluth sewage treatment plant bay) and one just upriver of 21st Avenue. Sediment analyses included particle size, total volatile solids, oil and grease, COD, total Kjeldahl N, total phosphorus, As, Cd, Ca, Pb, Hg, and Zn. Benthos were quantified and generally identified to the generic level. Water quality parameters which were analyzed included D.O., temperature, pH, turbidity, conductivity, alkalinity, total nitrogen, and total phosphorus. Qualitative analyses were made of phytoplankton and zooplankton, although the few genera presented indicates only a partial list of phytoplankton. Species lists and total catch per gill net lift and seine haul are presented for fish. Total and fecal coliform counts are tabulated. A discussion and partial species list of aquatic and terrestrial vegetation is also included. Samples were collected in 1970, 1972, and 1973 with most from 1973.

Availability: Lake Superior Basin Studies Center Reference Library, (SLR 45) CLSES Library (7A/8 and 7A/12 Appendices)

Subjects: Water quality, sediment chemistry, zooplankton, phytoplankton, vegetation, microbiology, benthos, fish

Estuary Location: Lower estuary

National Biocentric, Inc. 1973b. Environmental review report for demonstration bubbler system in the Superior entry, Duluth-Superior harbor. National Biocentric, Inc., St. Paul, Minnesota. 106 pp.

Chemical, physical, and biological monitoring was conducted to assess the impacts of an experimental bubbler system operated during the winter of 1972-1973 near the Superior entry. Temperature and oxygen profiles, qualitative and quantitative benthos samples, ice development, sediment particle size, and sediment and water chemical analyses are presented. Sediment analyses included volatile solids, total P, total N, oil and grease, arsenic, Cd, Cu, Pb, Hg, and Zn. Water analyses included total, suspended and volatile solids, total PO_4, available PO_4, total N, Kjeldahl N, NH_3-N, NO_3-N, pH, conductivity, turbidity, arsenic, Cd, Cu, Pb, Hg, and Zn.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 46)

Subjects: Water quality, sediment chemistry, physical processes, benthos

Estuary Location: Superior harbor

Niemi, G. 1978. Appendices to: flora and fauna of the Western Waterfront Trail. Department of Biology and Lake Superior Basin Studies Center, University of Minnesota, Duluth, Minnesota. 125 pp.

These appendices contain raw field data used in preparation of the report by the same name. Appendices include a bird species list, spring bird species summary, fall bird species summary, mammal summary, and reptile and amphibian summary. Surveys are all from the area of the Western Waterfront Trail, but counts are presented for eight specific sites within that area.

Availability: Lake Superior Basin Studies Center Reference Library (W/R3)

Subjects: Birds and other fauna

Estuary Location: Indian Point to Mud Lake

Niemi, G.J., T.E. Davis, and P.B. Hofslund. 1979a. Distribution and relationship of habitats and birds in the St. Louis River estuary. Lake Superior Basin Studies Center, University of Minnesota, Duluth, Minnesota. 99 pp. (plus appendices in separate volume).

This report summarizes work conducted on estuarine habitats and birds during 1978 and 1979 as well as 1976 and 1977 as reported by Niemi, et al, 1977, and Davis, et al, 1978. Quantitative and qualitative bird observations were divided into spring migration, breeding season, fall migration, and winter season. All vegetational habitat types of one hectare or larger were mapped. Individual bird species are discussed.

Availability: Lake Superior Basin Studies Center Reference Library (W/H12a)

Subjects: Birds, vegetation

Estuary Location: Entire

Niemi, G., T.E. Davis, and P.B. Hofslund. 1979b. Appendices to: distribution and relationship of habitats and birds in the

St. Louis River estuary. Department of Biology and Lake Superior Basin Studies Center, University of Minnesota, Duluth, Minnesota. 71 pp.

These appendices include a comprehensive literature review of regional journal publications concerning specific sightings and other isolated avian observations. Since this type of article was beyond the scope of this annotated bibliography, but may be of interest to users, Niemi's literature review is here included in its entirety. This review is complete through 1978. Additional publications since 1978 have been added.

Agassiz, L. 1850. Lake Superior, its physical character, vegetation, and animals, compared with those of other and similar regions. Gould, Kendall, and Lincoln, Boston. 428 pp.

Aguar, C.E. and J.T. Morse. 1966. Urban beautification and improvement program. Report to City of Duluth by Aguar, Jyving, Whiteman, Moser consultants.

Barrett, L.L. 1949. Parasitic Jaegers at Minnesota Point, Duluth. Flicker 21:118.

Baumhofer, J.A. 1971. Possible Smith's Longspurs, Duluth. Loon 43:56.

Bernard, R.F. 1965. A specimen of the Glaucous Gull from Douglas Co. Passenger Pigeon 27:71-2.

Bernard, R.F. 1966. A Yellow Rail in Douglas County. Passenger Pigeon 28:148.

Bernard, R.F. 1967. The Birds of Douglas County, Wisconsin. Passenger Pigeon 29:3-36.

Bernard, J.M. and D.W. Davidson. 1969. A floristic resurvey of a landfill area 32 years after deposition: the Oatka Beach addition. Minnesota Point, Minnesota. Amer. Midland Naturalist. 82:559-563.

Bernard, J.M., D.W. Davidson, and R.G. Koch. 1971. Ecology and floristics of Knife Island, a gull rookery on Lake Superior. J. Minn. Acad. Science. 37:101-103.

Brekenridge, W.J. 1944. Reptiles and amphibians of Minnesota. University of Minnesota Press, Minnesota. 202 pp.

Bronoel, J.K. 1947. Observations on Minnesota Point. Flicker 19:76-77.

Bronoel, J.K. 1948. Harbor Island, St. Louis Bay, Duluth. Flicker 20:107.

Bronoel, J.K. 1951. Census review, Harbor Island Duluth, Minnesota. Flicker 23:57-8.

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Bronoel, J.K. 1953. Black Tern Colony, St. Louis Bay. Flicker 25:126.

Bronoel, J.K. 1954. Census of Harbor Island in St. Louis Bay - 1954. Flicker 26:118.

Bronoel, J.K. 1955. Census of Harbor Island in St. Louis Bay - 195. Flicker 27:174.

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Burt, H.W. 1957. Mammals of the Great Lakes region. University of Michigan Press. Ann Arbor. 246 pp.

Campbell, D. 1961. Duluth, September 16, 1961. Flicker 33:125-26.

Carr, M.M. 1972. Minnesota's first verified Pomarine Jaeger. Loon 44:88-89.

Center for Lake Superior Environmental Studies. 1976. Environmental inventory of lower St. Louis River covering proposed improvements to the Duluth-Superior Harbor, Minnesota and Wisconsin. Contract No. DACW - 37 - 75-C-0202, Cont. Publ. No. 34.

Cohen, R.R. 1958. Common Tern Colony on Barkers Island, St. Louis Bay, Flicker 30:39.

Cohen, R.R. 1959. Immature Mockingbird at Duluth. Flicker 31:133.

Cohen, R.R. 1960. A study of Harbor Island, Duluth. Flicker 32:73-75.

Cohen, R.R., and S.B. Cohen. 1961. Second year study, Harbor Island, Duluth. Flicker 33:11.

Conklin, G.H. 1914. Preliminary report on a collection of Hepaticae from the Duluth-Superior District. Transactions Wis. Academy of Science, Arts and Letters Vol. XVII. 985-1010 pp.

Davidson, D.W. and J.M. Bernard. 1969. Mature pine forests in the Duluth harbor area. J. Minn. Acad. Science. 35:118-121.

Davis, T., G. Niemi, J. Kotar, and P. Hofslund. 1978.

Assessment of habitat types and bird populations of the lower St. Louis River estuary-Phase II. Rep. to Metropolitan Interstate Comm., Duluth, MN. 95 pp.

DeVore, P. 1978. Fishery resources of the Superior-Duluth estuary. Rep. to Metropolitan Int. Comm. 80 pp.

Eckert, K.R. 1968. Possible Gyrfalcon at Duluth. Loon 40:55.

Eckert, K.R. 1974. A birders guide to Minnesota. Circle Printing Co. Inc., Minneapolis. 114 pp.

Eckert, K.R. 1977. Two Harlequin Ducks in Duluth. Loon 49:243.

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Eckert, K.R. 1978. Another Laughing Gull at Duluth. Loon 50:167-68.

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Elwell, M.I. 1939. List of birds seen. Flicker 11:19.

Engstrom, H.R. 1939. 1939 Minnesota nesting records. Flicker 11:9-15.

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Faanes, C. 1978. Weather grounded migrants in Douglas County. Passenger Pigeon 40:386-87.

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Green, J.C. 1962. White-winged, Surf and Common Scoters in Dululth. Flicker 34:27.

Green, J.C. 1962. Harlequin Duck seen at Duluth. Flicker 34:63.

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Green, J.C. 1962. Arrested passerine migration and kill at Lake Superior. Flicker 34:110-12.

Green, J.C. 1962. Unusual fall migration in Duluth. Flicker 34:131.

Green, J.C. 1964. Jaegers seen near Duluth again in the fall of 1964. Loon 36:139.

Green, J.C. 1965. Barrow's Goldeneye. Flicker 37:84-85.

Green, J.C. 1965. Observations of an incomplete albino Bonaparte's Gull. Loon 27:107-08.

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Green, J.C. 1976. Great Black-backed Gull in Duluth. Lon 48:176.

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Green, J.C. 1976. Iceland Gull at Duluth. Loon 48:71.

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50:173-74.

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Harrel, B.E. 1942. Minnesota nesting records, 1942. Flicker 14:3-40.

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Harris, J.T. and S.W. Matteson. 1975. Gulls and terns as indicators of man's impact upon Lake Superior. University of Wisconsin Sera Grant College Program, Tech. Rpt. #227, Madison, Wisconsin.

Harris, J.T. and S.W. Matteson. 1975. Gulls and terns nesting at Duluth. Loon 47:70-5.

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Availability: Lake Superior Basin Studies Center Reference Library (W/H12b)

Subject: Birds

Estuary Location: Entire

Niemi, G., T. Davis, J. Kotar, and P. Hofslund. 1977. Assessment of habitat types and bird populations in the Duluth-Superior harbor. University of Minnesota, Duluth, Minnesota. 75 pp. (plus appendices)

See Niemi, et al. (1979) for basic objectives and content. This report was the first phase and included data and observations for the lower estuary only (below Arrowhead Bridge).

Availability: Lake Superior Basin Studies Center Reference Library (W/H6 and W/H6b)

Subjects: Birds, vegetation

Estuary Location: Lower

Northwest Paper Company, 1972. Dissolved oxygen - St. Louis River. Northwest Paper Company, Cloquet, Minnesota. 23 pp. (Mimeographed)

Dissolved oxygen, temperature, discharge, and BOD at ten sample points, from above Cloquet to the Oliver Bridge. Daily records are for most of the month of September, 1972. A limited D.O. sampling program has been conducted for a number of years. More data is available from the Northwest

Paper Company.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 47)

Subjects: Water quality

Estuary Location: Upper

Peterson, A. R. 1979. Fish and Wildlife Survey of the St. Louis River. **Minnesota Department of Natural Resources Special Publication** No. 127:103 pp.

Physical, chemical, and biological characterization of the St. Louis River from source to mouth. Deals primarily with the upper river, but does contain some data from the estuary. The report summarizes information collected during 1968 and 1976-1977 MDNR surveys. It also incorporates some information from 1941 and 1974 seine collections. Water chemistry measurements were nitrogen, phosphorus, sulphates, total alkalinity, pH and total iron. Conductivity, temperature, and water transparency were also measured. Fish surveys used trapnets and electrofishing. Also included are notes on terrestrial vegetation, aquatic vegetation, birds and mammals.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 48)

Subjects: Water quality, fish, vegetation, birds

Estuary Location: Upper estuary

Prater, B. L., and M. A. Anderson. 1976. A 96-hour sediment bioassay of Duluth and Superior Harbor basins (Minnesota) using **Hexagenia limbata, Asellus communis, Daphnia magna,** and **Pimephales promelas** as test organisms. United States Environmental Protection Agency, Region 5, Chicago, Illinois. 17 pp.

A more detailed in-house report of the study by the same name reviewed as Prater and Anderson (1977). Includes a map of sampling locations which is not included in the 1977 report.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 49)

Subjects: Sediment chemistry, water quality

Estuary Location: Lower

Prater, B. L. and M. A. Anderson. 1977. A 96-hour sediment bioassay of Duluth and Superior harbor basins (Minnesota) using **Hexagenia limbata, Asellus communis, Daphnia magna,** and **Pimephales promelas** as test organisms. **Bulletin of Environmental Contamination and Toxicology**, 18:159-169.

Describes bioassay procedures and results for the above organisms. Also includes tables of the inorganic and metal chemistries of the water and sediments.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 50)

Subjects: Sediment chemistry, water quality

Estuary Location: Lower

Quirk, Lawler, and Matusky. 1966. Study of the waste assimilation capacity of the St. Louis River, Cloquet to Superior. Quirk, Lawler, and Matusky, Water Resources Engineers, New York, New York. 66 pp. (report to Northwest Paper Company)

A mathematical model is constructed to predict the amount of treatment necessary to maintain adequate oxygen levels in the lower St. Louis River. Calculations include volumes, mean depths, and travel times for estuarine water at different discharges. Water BOD, sediment oxygen demand, atmospheric and mechanical reaeration, seiche, and algae are considered as variables.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 51)

Subjects: Physical processes, water quality

Estuary Location: Entire

SERCO. 1982. Laboratory analysis report No. 294. Sanitary Engineering Laboratories, Inc. Roseville, Minnesota. 2 pp. (Mimeographed)

Three sediment cores were analyzed in three fractions for total solids, NH_3-N, total-P, PCB, Cu, Zn, Cd, Pb, Mn, and As. Samples were collected in midwinter, 1982 alongside the DM&IR docks prior to dredging during the summer of 1982.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 52)

Subject: Sediment chemistry

Estuary Location: DM&IR docks

Scharf, W.C. 1978. Colonial birds nesting on man-made and natural sites in the United States Great Lakes. United States Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 136 pp. (Technical Report D-78-10, report no. FWS/OBS-78/15. Prepared for United States Fish and Wildlife Service and United States Army Corps of Engineers)

This two year census of colonial nesting birds includes quantification of nesting pairs of herring gulls, ringbilled gulls, and common terns at the Port Authority and MP & L's Hibbard plant. Vegetation was also examined qualitatively and assigned importance values. Observations were made in 1976 and 1977.

Availability: Lake Superior Basin Studies Center Reference Library (D/HC28)

Subjects: Birds, vegetation

Estuary Location: Hibbard Power Plant, Port Authority

Schram, S. 1978. Winter evaluation of shoal areas - Superior harbor. Wisconsin Department of Natural Resources. [interdepartmental memo], 8 pp. (plus field data)

Four sites in the lower estuary were gill netted during the winter of 1978. Food habits and distribution at each site with depth was evaluated. Dissolved oxygen levels were also measured at surface and bottom.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 95)

Subjects: Fish, water quality

Estuary Location: Lower

Schram, S. 1982. Characteristics of a northern pike population in a Lake Superior estuary. Wisconsin Department of Natural Resources, Brule, Wisconsin. 33 pp. (Mimeographed)

Spawning areas, migration patterns, age and growth data, mortality rates, and harvest rates are identified for northern pike in the lower portion of the estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 53)

Subject: Fish

Estuary Location: Lower estuary

Schraufnagel, F.H., L.A. Mantie, L.A. Lueschow, and K. Flasshof. 1966. Report on an investigation of the pollution in the Lake Superior drainage basin during 1965 and early 1966. United States Department of Interior, Federal Water Pollution Control Administration, Washington, D.C. pp. 455-486. (Proceeding, Vol. 2 of the Conference on Pollution of Lake Superior and its Tributary Basin, Minnesota-Wisconsin-Michigan.)

This report summarizes an investigation of industries on Wisconsin tributary streams to Lake Superior and identifies specific industrial pollution sources within Wisconsin waters of the St.Louis River estuary. These sources are listed along with a classification of type of waste, treatment system, estimated daily discharge, and the 5-day BOD of the waste.

Availability: Lake Superior Basin Studies Center Reference Library (P/W2c), CLSES Library (1B/34)

Subject: Water quality

Estuary Location: Lower estuary

Sevener, Greg. 1978. Lake Superior drainage basin report. Wisconsin Department of Natural Resources, Northwest District Office, Spooner, Wisconsin. 329 pp.

This report identifies water quality problems and specific pollutant sources (point and nonpoint). It discusses abatement needs within Wisconsin waters of the Lake Superior drainage basin. Sub-basins discussed which are of interest to this bibliography are identified as St. Louis Bay, St. Louis River, Pokegama River, Winter Street drainageway, Superior Bay, Newton Creek, Nemadji River, Crawford Creek, Bluff Creek, and Bear Creek. Benthos analyses were qualitative with tolerant-intolerant classifications. Water quality information is presented for 72 sites sampled from 1 to 38 times in 1974 through 1976. Measured parameters usually included only fecal coliform, DO, pH, and BOD, but in some instances added total solids, volatile solids, organic-N, NH_3-N, NO_2-N, NO_3-N, total-P, soluble-P, and Cl.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 54)

Subjects: Benthos, water quality

Estuary location: entire, including tributaries and pollutant point sources

Sheffy, T.B. and T.M. Aten. 1979. 1979 annual summary of PCB levels in Wisconsin fish. Wisconsin Department of Natural Resources, Bureau of Water Quality, Madison, Wisconsin. 51 pp. (Mimeographed)

Summary of PCB analyses for watersheds throughout Wisconsin. Fillet, edible portion (whole fish without head or entrails), and whole fish analyses are included, although most analyses are of fillets. Analyses within the St. Louis River estuary are for the years 1974 and 1976-1978.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 55)

Subject: fish contaminants

Estuary Location: lower

Sheffy, T.B., J.R. St. Amant, and M.E. Pariso. 1981. Toxic substances survey of Lake Michigan, Superior, and tributary streams: second annual report. Wisconsin Department of Natural Resources, Bureau of Water Quality Management, Madison, Wisconsin. 42 pp.

This report contains analyses for fish tissue, sediments, and point source effluents from the estuary as well as other Lake Superior basin sites. Fish tissues were analyzed in 1979 and 1980 for PCB, two forms of DDT, DDD, and DDE, dieldrin, endrin, methoxychlor, hexachlorobenzene, pentachlorophenol, hexachlorocyoclohexane, As, Cr, Cu, Hg, and Pb. Fish were sampled in the Nemadji River mouth and in the St. Louis River. Species included nothern pike, burbot, black crappie, white sucker, carp, yellow perch, silver redhorse, black bullhead, and walleye. One sediment sample was analyzed from the Nemadji River at Crawford Creek.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 56)

Subjects: Fish contaminants, sediment chemistry

Estuary Location: Entire

Skrypeck, J. L. 1973. Concentrations of some organochlorine insecticides and polychlorinated biphenyls in flesh and brain tissue of Minnesota fish collected in 1970. **Minnesota Department of Natural Resources Special Publication No.** 103:29 pp.

This report contains analyses for the same compounds as Moyle and Skrypeck (1972). It includes only one sucker from the estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 57)

Subject: fish contaminants

Estuary Location: --

Stepun, J. J. 1982. Western Lake Superior Sanitary District biological monitoring. Western Lake Superior Sanitary District, Duluth, Minnesota. 404 pp.

This report is a detailed summary of a number of bioassays conducted with water from influent and effluent points within the WLSSD system. Section titles are "Static Screening Bioassays," (October, 1980); "Proportional Diluter Bioassays," (January-February, 1981); Aquarium Flow-through Bioassay"; "Mammal Enzyme Inhibition"; "Auxillary Test Procedures," (discusses use of algal fluorescence and enzyme immobilization); "Plant Carbon Dioxide Probe Data"; "Bioassay Notebook: Methods, Notes, Raw Data, etc."; "Correspondence"; and "Carbon Dioxide - Oxygen Tolerance" (bioassays to determine CO_2 tolerance at various DO levels). The "Correspondence" section contains such information as: observations and identifictaion of ammonia as the lethal agent in a 1980 fish kill in the bay at the effluent points, 1980 MPCA bioassay tests and results, and an industrial/commercial waste survey questionnaire from Potlatch.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 58)

Subjects: Fish, water quality

Estuary Location: --

Stortz, K.R. and M. Sydor. 1980. Transports in the Duluth Superior harbor. **Journal of Great Lakes Research** 6 (3):223-231.

Hydrodynamic and water quality models for the estuary are discussed. Pollutant resuspension and redistribution by ship traffic is quantified as is pollutant residence time in the harbor.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 59)

Subjects: Physical processes, water quality

Estuary Location: Lower estuary

Swain, W. R., R. M. Wilson, and G. S. Porter. 1975. Persistent organic and heavy metal residues in the near-shore fishery

of western Lake Superior. University of Minnesota, Duluth, Minnesota. 185 pp.

A survey which sampled and analyzed fish tissue from 113 stations within Lake Superior. Analyses included the heavy metals, zinc, copper, nickel, chromium, cadmium, lead, mercury, arsenic, and selenium and persistent organic compounds including PCB, hexachlorobenzene, alphabenzene, hexachloride, lindane, beta chlordane, p, p-DDE, o, p-DDD, p, p-DOT, heptachlor expoxide, dieldrin, endrin, mirex, methoxychlor, diethyl phythalate, dibutyl phthalate diethyl hexyphthlate, and hexachlorobutadiene. Measurements within the St. Louis River estuary included only mottled sculpins. No determinations were made for heavy metals.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 60-special)

Subject: Fish contaminants

Estuary Location: Minnesota Point

Swain, W. R., R. M. Wilson, R. P. Neri, and G. S. Porter. 1975. Evaluation of the effects of a harbor bubbler system for winter navigation on the water quality of Howard's Bay in the Duluth-Superior harbor. University of Minnesota, Duluth, Minnesota. 165 pp. (United States Army Corps of Engineers contract no. DACW 37-75-C-0124.)

Water quality parameters were measured through the ice on five sampling dates prior to bubbler operation and four days after operation. On two additional post-operational days samples were taken before and after agitation by ship traffic. Physical and chemical parameters measured were temperature, conductivity, dissolved oxygen, pH, ammonia, nitrites, nitrate, total phosphorus, soluble orthophosphorus, suspended solids, total solids, dissolved solids, alkalinity, chemical oxygen demand, cadmium, arsenic, lead, zinc, copper, mercury, lindane, benzene hexachloride, hexachlorobenzene, heptachlor epoxide, PCB, and phthalate esters. The impact of the bubbler on resuspension of polutants was not deemed significant compared to the impact of vessel traffic.

Availability: Lake Superior Basin Studies Center Reference Library (S/HW1)

Subject: Water quality

Estuary Location: Howard's Bay

Sydor, M. 1974. Ice growth in Duluth-Superior harbor and western Lake Superior. **Remote Sensing of Earth Resources** Vol. 3:107-

116. (F. Shahrokhi, editor, University of Tennessee at Tullahoma).

See Sydor, 1978.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 61)

Subject: Physical processes

Estuary Location: Entire

Sydor, M. 1978. Ice Growth in Duluth-Superior harbor. **Journal of Geophysical Research** 83 (C8):4074-4078.

Identifies factors affecting rates and thickness of ice growth in different portions of the estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 62)

Subject: Physical processes

Estuary Location: Entire

Sydor, M., J.A. Sorensen, and V. Shuter. 1979. Remote sensing of snow albedo for determination of dustfall. **Applied Optics** 18(21):3574-3578.

Landsat computer tape data was used to measure rates of dustfall within the estuary. Dustfall could be correlated with various point sources.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 63)

Subjects: Physical processes, water quality

Estuary Location: Entire

Sydor, M., and K. Stortz. 1980. Sources and transport of coal in the Duluth-Superior harbor. United States Environmental Protection Agency, Duluth, Minnesota, 84 pp. (United States Environmental Protection Agency, Duluth, Minnesota, Publication no. EPA-600/3-80-007, 84 pp.)

This study estimates the total quantity of wind-blown coal dust which enters the estuary and directly into Lake Superior. It also presents estimates of total coal particles reaching Lake Superior by water, the time taken to travel that distance, and the relative concentration of a pollutant traveling that distance.

Availability: Lake Superior Basin Studies Center Reference Library (E/C8),CLSES Library (6/16)

Subjects: Water quality, physical processes

Estuary Location: Lower estuary

Twin City Testing and Engineering Laboratory, Inc. 1973. Sediment samples from Duluth-Superior harbors. Twin City Testing and Engineering Laboratory, Inc., St. Paul, Minnesota. 3 pp. (Mimeographed)

Thirty sediment samples collected by the Corps of Engineers in April, 1973 were analyzed for volatile solids, COD, total Kjeldahl-N, oil and grease, Hg, Pb, and Zn.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 64)

Subject: Sediments chemistry

Estuary Location: Duluth and Superior Harbor basins

United States Army Corps of Engineers. 1974. Final environmental impact statement - Duluth-Superior harbor maintenance and operation activities. United States Army Corps of Engineers, St. Paul District, St. Paul, Minnesota. 150 pp. (plus appendices)

This report repeats tables as originally presented by Weston (1974) and National Biocentrics (1973). Some additional E.P.A. analyses of sediments at the same sites are tabulated.

Availability: Lake Superior Basin Studies Center Reference SLR 65. CLSES Library (7A/9)

Subjects: Fish, sediment chemistry, benthos, water quality, microbiology phytoplankton, zooplankton, vegetation

United States Army Corps of Engineers. 1975. Draft environmental impact statement, proposed refined products terminal, Lakehead Pipe Line Co., Inc., Superior, Douglas County, Wisconsin. United States Army Corps of Engineers, St. Paul District, St. Paul, Minnesota. 87 pp. (plus appendices)

This EIS presents a compilation of information on water quality, sediments, fish, benthos, plankton, vegetation, avifauna, and mammals compiled primarily from sources reviewed within this bibliography. These are: Weston, 1974; National Biocentrics, 1973; American Bechtel, 1974.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 66) CLSES Library (7A/19)

Subjects: Water quality, sediment chemistry, fish, benthos, phytoplankton, zooplankton, vegetation, birds

Estuary Location: Lower estuary

United States Army Corps of Engineers. 1976. Duluth-Superior and adjoining area urban study, Appendix urban area I. United States Army Corps of Engineering, St. Paul, Minnesota. 337 pp.

This report focuses on water-related problems in the Duluth-Cloquet-Superior area. Its intent is to outline a plan for restoring the lower St. Louis River and estuary to its productive and aesthetic natural resource base through removal or management of existing sludge deposits and waste-water control. Included are summary tables from state agency and consulting firm studies on sediment oxygen uptake, sediment pollutants (Spirit Lake), Minnesota pollutant dischargers to the bay and river, mercury levels in fish (1971-1973), and three-year (1973-1975) BOD and dissolved oxygen levels from 15 points along the St. Louis River and estuary.

Availability: Lake Superior Basin Studies Center Reference Library (H/CMIb)

Subjects: Sediments chemistry, water quality, fish contaminants

Estuary Location: Spirit Lake, river to Cloquet

United States Army Corps of Engineers. 1977. Final supplement, Final environmental impact statement: Duluth-Superior Harbor operation and maintenance. United States Army Corps of Engineers, St. Paul District, St. Paul, Minnesota. 50 pp. (plus appendices)

This report contains reports for 1976 bottom sediment analyses for sediment size and chemistry (see U.S.E.P.A., 1977) and PCB's (see Whiting, 1977).

Availability: Lake Superior Basin Studies Center Reference Library (SLR 67) CLSES Library (7A/9B)

Subjects: Sediment chemistry

Estuary Location: Lower estuary

United States Army Corps of Engineers. 1982. Bottom sediment analysis for the Duluth-Superior Harbor. (Mimeographed)

This mimeo includes analyses of bottom sediments from 25 sites from just above the Arrowhead Bridge to Allouez Bay. Five to eight foot cores were taken and divided into one or two samples. Analyses were grain size, percent solids, percent volatile solids, TOC, COD, oil and grease, cyanide, phenols, total-P, ortho-P, TKN, NH_3-N, As, Fe, Cd, Cu, Cr, Ni, Mn, Pb, Hg, Zn, and total PCB's. Elutriates were also tested at some sites. Benthos was analyzed at four sites. All samples were collected in March, 1982.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 68)

Subject: Physical processes, sediment chemistry, benthos

Estuary location: Arrowhead Bridge to Allouez Bay

United States Department of the Interior. 1967. Immediate water pollution control needs of the St. Louis River Basin, Minnesota and Wisconsin, Lake Superior watershed. Federal Water Pollution Control Administration, Chicago, Illinois. 33 pp.

Most of this report addressed pollution sources and treatment needs within the St. Louis River Basin. It does cite information from an unpublished 1961 survey by the Minnesota Department of Health. Included are total coliform counts, BOD, and DO.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 69)

Subjects: Water quality, microbiology

Estuary Location: Entire

United States Department of the Interior. 1968. Environmental effects of pollution and diversion on the St. Louis River. United States Department of the Interior, Upper Mississipi - Western Great Lakes Area, Duluth, Minnesota. 33 pp. (Federal Pollution Control Project No. 2360)

This report was prepared at the request of Under Secretary Black to investigate complaints of water quality and river diversions not in compliance with federal statutes. It includes a resume' of water quality, background on water diversion and use, State of Minnesota standards for the St. Louis River, a Minnesota DNR preliminary report on environmental and fish habitat conditions in the lower St.

Louis River and potential as a salmon stream, historical water quality records, and a good account of a life-long area resident's fishing and water quality experiences on the estuary. Contained within this memorandum is apparently the earliest water quality record of the lower St. Louis River (1904-1905). Listed parameters are alkalinity, sulfate, chloride, nitrogen, dissolved solids, and iron.

Availability: Lake Superior Basin Studies Center Reference Library (RV/M8)

Subjects: Water quality, fish, physical processes

Estuary Location: Upper estuary and lower St. Louis River

United States Environmental Protection Agency. 1982. STORET (Storage and Retrieval Data System; Available portion covers only St. Louis River - see annotation) 500 pp.

This information retrieval system contains data on water quality, sediment chemistry, fish contaminant analyses, coliform counts, and chlorophyll analyses. Most such analyses conducted by the EPA, Wisconsin Department of Natural Resources, Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, and Western Lake Superior Sanitary District are included within the system. Other miscellaneous studies and contributors can also found here. Much of the information reviewed elsewhere in this bibliography can be found within this system. The Lake Superior Basin Studies Center Reference Library contains a 1982 printout which gives a summary of all data collected within the estuary. This is a breakdown by site, agency, range of collection dates, parameters monitored, and the range and average values of these parameters.

Availability: U.S.E.P.A., summary printout at the Lake Superior Basin Studies Center Reference Library (SLR 96 - computer printout)

Subjects: Fish contaminants, microbiology, phytoplankton, sediment chemistry, water quality

Estuary Location: Entire

United States Environmental Protection Agency. 1970. Field report and sediment pollution evaluation, Duluth-Superior Harbor, June 17, 1970. United States Environmental Protection Agency. Region V, Chicago, Illinois. (Data contained in another report)

Bulk sediment was analyzed from eight sites in the Duluth and Superior harbor basins. Parameters analyzed were percent volatile solids, COD, total Kjeldahl nitrogen, oil

and grease, Hg, Pb, Zn, and total-P. The original report is not available, but analytical data are contained in U.S.E.P.A. (1975a).

Availability: Lake Superior Basin Studies Center Reference Library (SLR 71)

Subject: Sediment chemistry

Estuary Location: Harbor basins

United States Environmental Protection Agency. 1975a. Duluth-Superior, Minnesota-Wisconsin, report on the degree of pollution of bottom sediments. United States Environmental Protection Agency, Region V, Great Lakes Surveillance Branch, Chicago, Illinois. 26 pp.

Twenty-five sediment samples from the Duluth Harbor Basin and twelve samples from the Superior Harbor Basin were analyzed for particle size and various chemical parameters including percentage solids, volatile solids, COD, total Kjeldahl nitrogen, oil anad grease, Hg, Pb, Zn, total P, NH_3-N, cyanide, phenols, Mn, Ni, As, Ba, Cd, Cr, Mg, Cu, and Fe. Sediment elutriate was also tested for most of the above parameters. Macroinvertebrate were identified and quantified for twelve samples. All samples were collected in May, 1975.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 71)

Subjects: Sediment chemistry, benthos

Estuary Location: Harbor Basins

United States Environmental Protection Agency. 1975b. Report on St. Louis Bay, St. Louis County, Minnesota and Douglas County, Wisconsin. United States Environmental Protection Agency, Region V, Chicago, Illinois. 31 pp. (Working Paper No. 123)

This study was part of the 1972 and 1973 National Eutrophication Survey. Physical and chemical parameters monitored at St. Louis River tributaries, wastewater treatment plants, and St. Louis Bay included DO, conductivity, pH, alkalinity, total-P, dissolved-P NO_2 + NO_3-N, NH_3-N, and secchi disk readings. Biological characteristics included quantitative and qualitative phytoplankton analyses and chlorophyll a measurements. A limiting nutrient study was conducted. Total phosphorus and nitrogen loading from the river system was estimated.

Availability: Lake Superior Basin Studies Center Reference

Library (SLR 72), STORET

Subjects: Water quality, phytoplankton

Estuary Location: St. Louis Bay

United States Environmental Protection Agency. 1975c. Report on Superior Bay, St. Louis County, Minnesota, and Douglas County, Wisconsin. United States Environmental Protection Agency Region V, Chicago, Illinois. 30 pp. (Working Paper No. 128)

This study was used with the same methods and analyses as USEPA (1975b), but was conducted in Superior Bay.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 73), STORET

Subjects: Water quality, phytoplankton

Estuary Location: Superior Bay

United States Environmental Protection Agency. 1977a. Duluth-Superior, Minnesota and Wisconsin, Report on the degree of pollution of bottom sediments, June 29-30, 1976. United States Environmental Protection Agency, Region V, Great Lakes Surveillance Section, Chicago, Illinois. 17 pp.

Analyses included sediment size and chemistries for 8 sites in the Duluth and Superior Harbor Basins. Samples were taken with both a sediment corer and Peterson grab sampler at each site. Cores were analyzed as top and bottom halves of 6 to 20 inch samples. Physical and chemical analyses included total solids, volatile solids, COD, total Kjeldahl N, oil and grease, Hg, Pb, Zn, total phosphorus, NH_3-N, Mn, Mg, Ni, As, Cd, Cr, Cu, and Fe. Bioassay results (conducted by the Minnesota Pollution Control Agency), while not detailed, are presented for each sampling site.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 74), In U.S. Army Corp of Engineers (1977) - CLSES Library (7A/9B)

Subject: Sediment chemistry, physical processes

Estuary Location: Lower estuary

United States Environmental Protection Agency, 1977b. St. Louis River, Minnesota--Report on the degree of pollution of bottom sediments. United States Environmental Protection Agency, Region V, Great Lakes National Program Office Surveillance and Research Staff, Chicago, Illinois. 34 pp.

Sediment samples were collected as cores 3 to 22 feet in depth. Cores were split horizontally into 2 or 3 samples. Analyses included PCB and pesticides at all sites and bulk and elutriate chemistry, particle size, and macroinvertebrate identification and enumeration at selected sites. All samples were collected in July, 1977.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 75)

Subjects: Sediment chemistry, benthos, physical processes

Estuary Location: Interstate Island to one mile above Arrowhead Bridge

United States Geological Survey. 1981. Water resources data for Minnesota, Water Year 1980, Volume I: Great Lakes and Souris-Red-Rainy river basins. United States Geological Survey, St. Paul, Minnesota. 234 pp. (United States Geological Survey Water Data Report No. MN 80-1)

This annual report contains daily discharge data for the St. Louis River at Scanlon, Minnesota.

Availability: United States Geological Survey - St. Paul (available yearly)

Subject: Physical processes

Estuary Location: --

Van Tassell, J. and J. Robert Moore. 1976. Final report an assessment of the environmental effects of dredged material disposal in Lake Superior, Volume 2, Sedimentation studies: Duluth-Superior and Keweenaw study areas. Marine Studies Center, Institute for Environmental Studies, University of Wisconsin, Madison, Wisconsin. 143 pp.

Sediments from the harbor area were analyzed for grain size and compared to near-shore Lake Superior sediments to assess the rate of settling and movement of dredge spoil dumped in Lake Superior. Samples were collected in 1973-1975.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 76) CLSES Library (7B/3A)

Subjects: Sediment chemistry, physical processes

Estuary Location: Lower estuary

Wechsler, C. 1980. Miracle of the St. Louis River. **Minnesota**

Fins and Feathers May, 1980: 6 pp.

A popular account of the 1978-1979 recovery of water quality and the fishery within the estuary.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 77)

Subjects: Water quality, fish

Estuary Location: Entire

Western Lake Superior Sanitary District. 1975a. Monitoring Report - St. Louis River. Western Lake Superior Sanitary District, Duluth, Minnesota. 63 pp.

This report describes the monitoring program which was begun in 1973 and displaced the 25-year program previously conducted by the City of Duluth Water and Gas and Sewage Departments. Included are physical characterization of the St. Louis River and 15 permanent sampling sites, including the six within the estuary. Trends in DO, BOD, coliform, and nutrients are described from point to point in the system. Major point-source pollution inputs and their location are described. Three year averages for BOD, DO, fecal and total coliform, phosphorus, and nitrogen are graphed as continuous for the 14 river and estuary stations. All of the 1975 biweekly water quality data is presented for all stations.

Availability: Lake Superior Basin Studies Center Reference Library (P/WM1)

Subject: Water quality, microbiology

Estuary Location: Entire

Western Lake Superior Sanitary District. 1975b. Western Lake Superior Sanitary District creek survey - high flow conditions. Western Lake Superior Sanitary District, Duluth, Minnesota. 60 pp.

Thirty creeks within Duluth were surveyed at different points during periods of high flow (spring run-off and summer storm events) to determine four water quality parameters. Tests were total and fecal coliform, biological oxygen demand, and phosphorus. The objective was to identify sources of sewage contamination.

Availability: Lake Superior Basin Studies Center Reference Library (P/WM5)

Subject: Water quality, microbiology

Estuary Location: Entire (tributaries)

Western Lake Superior Sanitary District. 1975c. Western Lake Superior Santitary District creek survey - low flow conditions. Western Lake Superior Sanitary District, Duluth, Minnesota. 66 pp.

Thirty creeks within Duluth were surveyed during periods of low flow (fall and winter, 1974) to determine four water quality characteristics. The objectives were to determine water quality of Duluth creeks and to locate sources of sewage contamination. Parameters tested were total and fecal coliform, biological oxygen demand, and phosphorus.

Availability: Lake Superior Basin Studies Center Reference Library (P/WNP6)

Subject: Water quality, microbiology

Estuary Location: Entire (tributaries)

Weston, R. F. Inc. 1974a. Appendices, Coal transshipment facility Superior, Wisconsin. Roy F. Weston, Inc., Environmental Consultants-Designers, Wilmette, Illinois. 150 pp.

This study is the environmental impact assessment for development of the ORTRAN facility. Included are surveys of terrestrial vegetation at the site, mammals, and avifauna. Water quality samples were taken through the ice at six sites between the Arrowhead Bridge and Minnesota Point. Parameters analyzed were Ca, Mg, Na, K, Fe, Mn, Cd, Zn, Pb, Hg, Cu, As, total-P, suspended solids, ortho-P, NO_2, NO_3, organic N, SO_4, Cl, pH, alkalinity, hardness, oil and grease, NH_3, COD, TOC, total solids, dissolved solids, BOD, fecal coliform, total coliform, selenium, and antimony. Sediment cores were taken at two sites near the terminal and one site along Minnesota Point. Thirty-two inch cores were divided into 7 to 9 "horizons" and analyzed independently. Analyses included percent water, percent volatile solids, COD, total Kejldahl N, total-P, oil and grease, Cu, Zn, Cd, As, Pb, and Hg. Five sites were sampled for benthos. Quantitative and qualitative tables are presented. All sampling was conducted during the winter and early spring of 1974.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 78) CLSES Library (7A/1)

Subjects: Vegetation, water quality, sediment chemistry, benthos, microbiology

Estuary Location: Lower estuary

Weston, Roy F., Inc. 1974b. Environmental impact report, taconite transshipment facility, Superior, Wisconsin. Roy F. Weston, Inc., Environmental Consultants Designers, Wilmette, Illinois. 164 pp.

This EIS included surveys of terrestrial vegetation, mammals (winter only), birds (winter only), water quality, sediments, and benthos. Summaries of phytoplankton, zooplankton, and fish from National Brocentric (1973) are presented. Sixteen sites from the Arrowhead Bridge to the Superior entry were sampled for water quality. Water quality parameters measured were fecal and total coliform, BOD, COD, NH_3-N, NO_2-N, NO_3-N, total and ortho-P, suspended solids, pH, antimony, As, Cd, Ca, Cu, Fe, Pb, Mg, Mn, Hg, K, Se, Na, Zn, chlorides, organic carbon, sulfates, hardness, alkalinity, total solids, and total dissolved solids. Water quality data is also presented for the mouth of the Nemadji River on two dates in 1973. Sediment cores were collected at three sites and analyzed at 2 to 15 "horizons" for COD, total Kjeldahl-N, total-P, total solids, volatile solids, oil and grease, As, Cd, Cu, Pb, Hg, and Zn. Benthos was sampled at 5 sites, identified to genus or species, and enumerated. All sampling was conducted during the winter of 1974.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 79) CLSES Library (7A/26)

Subjects: Vegetation, microbiology, water quality, sediment chemistry, benthos, birds

Estuary Location: Lower estuary

Weston, Roy F., Inc. 1976. Comparison of dipper and hydraulic dredging at Superior, Wisconsin. Roy F. Weston Environmental Consultants-Designers, Wilmette, Illinois. 28 pp. (plus appendices)

Data is presented to indicate the potential impacts of additional dredging at Burlington Northern's taconite transshipment facility. Included are soil analyses of three 36 foot cores, chemical analyses of cores as presented in Weston, 1974, and quantitative and qualitative benthos analyses. Samples were collected in 1974 and 1975.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 80)

Subjects: Physical processes, sediments chemistry, benthos

Estuary Location: Allouez Bay

Whiting, R.J. 1977. Report on the Duluth-Superior harbor 1977 PCB sampling program. United States Army Corps of Engineers, St. Paul District, St. Paul, Minnesota. 17 pp.

Thirty stations (19 in the Duluth Harbor Basin, 10 in the Superior Harbor Basin, and 1 in the West Gate Basin) were sampled using a surface grab (Ponar) and a 2.5 yd^3 clam shell dredge. A core from the clam shell dredge was split (upper and lower) for analysis. Total PCB concentration was determined for all samples. The specific arochlors were identified in a subsample. All samples were collected on June 21-29, 1977.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 81), in U.S. Army Corp of Engineers (1977), CLSES library (7A/93)

Subject: Sediment chemistry

Estuary Location: Lower estuary

Winter, D. R. 1968. Report on the water quality survey in Wisconsin waters of Lake Superior made during July, 1968. United States Department of Interior, Federal Water Pollution Control Administration, Washington, D.C. 31 pp. (pp. 511-530 in Proceedings volume 2 of the Conference on Pollution of Lake Superior and its Tributary Basin, Minnesota - Wisconsin - Michigan).

This report included eight sampling stations in the lower estuary and approximately 28 sites in Lake Superior in the proximity of the estuary. Benthos was collected with grab samples, enumerated, and classified as to tolerance level. Plankton samples were taken with a 20 mesh Clark-Bumpus sampler. Although the text indicated more in-depth analyses, the tabulated values for each sample are percent zooplankton, protozoans, diatoms, bluegreen algae, green algae, organic debris, and inorganic debris. Additional measurements included nitrogen as total organic, ammonia, nitrite, nitrate, and total inorganic, soluble and total phosphorus, fixed solids, and volatile solids. Observations were made as to presence of absence of Cladophora growth.

Availability: Lake Superior Basin Studies Center Reference Library (P/W2c)

Subjects: Benthos, zooplankton, phytoplankton, water quality

Estuary Location: Lower

Wisconsin Department of Natural Resources. 1968. Walleye study. Wisconsin Department of Natural Resources, Madison, Wisconsin. 5 pp. (Mimeographed)

The second year of the three-year tagging study of the Superior to Iron River walleye population is discussed (see WDNR, 1969). Number of fish tagged, angler and sampling recapture rates, patterns of movement, length frequency, age-growth, and infection rates of walleye by Ergasilus is presented.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 82)

Subject: Fish

Estuary Location: Entire

Wisconsin Department of Natural Resources. 1969. Western Lake Superior walleye study, Wisconsin Department of Natural Resources, Madison, Wisconsin. 6 pp. (Mimeographed)

Results of a tagging study of the Superior-Iron River walleye population are presented. Number tagged, recapture rate, and movement are discussed. Age and growth as determined by scale examination is presented.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 83)

Subject: Fish

Estuary Location: Entire

Wisconsin Department of Natural Resources. 1972a. St. Louis-Superior Bay, Wisconsin Department of Natural Resources, Madison, Wisconsin. 3 pp. (Mimeographed)

Temperature, dissolved oxygen, secchi disk, and fecal coliform counts at 10 stations from Hwy. 23 to the Superior entry in July, 1972.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 84)

Subjects: Water quality, microbiology

Estuary Location: Entire

Wisconsin Department of Natural Resources. 1972b. Surface water quality record--St. Louis River, Wisconsin Department of Natural Resources, Madison, Wisconsin. 1 p. (Mimeographed)

Monthly analyses of fecal coliform, BOD, total, suspended, and volatile solids, total organic N, NO_3-N, NO_2-N, NH_4-N, total-P, soluble-P, alkalinity, hardness, color, pH, chloride, and DO. All samples collected between April and December, 1972, at the Hwy. 105 bridge.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 85)

Subjects: Water quality, microbiology

Estuary Location: Hwy. 105 (Oliver)

Wisconsin Department of Natural Resources. 1975. Wisconsin tributary loadings to the upper Great Lakes. Wisconsin Department of Natural Resources, Madison, Wisconsin. 59 pp. (United States Environmental Protection Agency, Environmental Monitoring Series, No. EPA-905/4-75-003)

Physical, chemical, and biological data is presented for the Nemadji River and Superior Bay adjacent to the river mouth. Monthly 1974 anad 1975 analyses included DO, pH, fecal coliform, BOD, total, suspended and volatile solids, total organic-N, NO_3-N, NH_3-N, NO_2-N, total-P, soluble-P, silica, total Fe, phenol, Mn, Cl, alkalinity, hardness, conductivity, color and turbidity. Additional metals analyses in 1974 were Cd, Cr, Cu, Pb, Hg, Ni, and Zn. Benthos was collected at four Nemadji River sites and eight estuarine sites on one date in 1974. Quantitative and qualitative data are presented, though taxonomy is only to order or family level.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 86)

Subjects: Water quality, microbiology, benthos

Estuary Location: Nemadji River and Superior Bay

Wisconsin Department of Natural Resources. 1976a. Basic inventory of lower St. Louis River, north of Route 105 bridge, Douglas County. Wisconsin Department of Natural Resources, Madison, Wisconsin. 13 pp. (Mimeographed)

Background information is presented along with fishery survey results from various studies conducted in 1975. Data presented are total catch, age and growth for walleye, northern pike, and yellow perch, food habits for walleye and yellow perch, and creel census results.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 87)

Subject: Fish

Estuary Location: Entire

Wisconsin Department of Natural Resources. 1976b. Miscellaneous file copies of water quality samples. Wisconsin Department of Natural Resources, Madison, Wisconsin. 18 pp.

These files contain water quality data from six sites in the lower estuary, water quality within and outside dredge curtains during dredging operations, and water quality of run-off from on land dredge spoil disposal. All sampling and analysis was conducted between February and October, 1976.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 88)

Subject: Water quality

Estuary Location: Lower

Wisconsin Department of Natural Resources. 1977a. 1976 survey of the lower St. Louis River and Superior harbor. Wisconsin Department of Natural Resources, Brule, Wisconsin. 7 pp. (Mimeographed)

Results of 1976 fishery survey are summarized and discussed by region within the estuary. Results of a creel census conducted during 1975 and 1976 are presented.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 89)

Subject: Fish

Estuary Location: Entire

Wisconsin Department of Natural Resources. 1977b. Superior harbor study. Wisconsin Department of Natural Resources, Madison, Wisconsin. 61 pp. (Mimeographed)

Sixteen estuarine stations were monitored from Billings Park to the Superior entry with 14 additional stations located in the vicinity of point-source outfalls. Monthly depth, temperature, and dissolved oxygen profiles were taken in 1976 with less intensive sampling in 1977. Measured water quality parameters were fecal coliform, BOD, pH, total solids, volatile solids, suspended solids, total-P, dissolved-P, total organic N, NH_4-N, NO_2-N plus NO_3-N, alkalinity, chlorides, color, conductivity, hardness, and

turbidity. Chlorophyll a was measured at some sites once in 1976. Cores were also taken at some sites once in 1976 and analyzed for Cd, Cr, Cu, Pb, Hg, Ni, and Zn.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 90)

Subjects: Water quality, sediment chemistry, phytoplankton, microbiology

Estuary Location: Lower

Wisconsin Department of Natural Resources. 1979. Pesticide analyses. Wisconsin Department of Natural Resources, Bureau of Water Quality, Madison, Wisconsin. 16 pp. (Mimeographed)

A compilation of bench sheets of fish analyses from near shore Lake Superior including the Superior entry. Most fish were collected in river mouths. Analyses include PCB, aldrin, endrin, dieldrin, O, P, and P, P DDE, DDD, and DDT, Cis- and Trans-chlordane, Cis and Trans-nonachlor, hexachlorobenzene, pentachlorophenol, alpha BHC, gamma BHC, and methoxychlor. All fish were collected in 1979.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 91)

Subject: Fish contaminants

Estuary Location: Superior entry

Wisconsin Department of Natural Resources. 1980. State of Wisconsin Surface Water Quality Monitoring Data, 1973-1976. Wisconsin Department of Natural Resources, Madison, Wisconsin. 189-192 pp.

Monthly monitoring of water quality at Hwy. 105 at Oliver for the years 1973-1976. This is a continuation of monitoring of the parameters as in Wisconsin Department of Natural Resources (1972b).

Availability: Lake Superior Basin Studies Center Reference Center Library (SLR 92), STORET

Subjects: Water quality, microbiology

Estuary Location: Hwy. 105 (Oliver)

Wisconsin Department of Natural Resources. 1982. 1981 Superior harbor index station report. Wisconsin Department of Natural Resources, Madison, Wisconsin. 41 pp.

(Mimeographed)

A detailed report of 1981 catches with meter net, seine, fyke net, and electrofishing. 1981 catches at index stations are compared to 1978 and 1980, the only other years which index stations were sampled. Also presented are monthly oxygen profiles (winter and summer) at 3 stations during 1981 and a comparison of midwinter oxygen levels during 1978, 1980, and 1981. Length-frequencies are presented for major species.

Availability: Lake Superior Basin Studies Center Reference Library (SLR 93)

Subjects: Fish, water quality

Estuary Location: Lower

Subject Index to Reviews by Author

Benthos

Croft, 1976
International Joint Commission, 1977
Koch et al, 1976
Magnuson et al, 1976
Maschwitz et al, 1976
Minnesota Department of Natural Resources, 1980a
Minnesota Department of Public Health, 1961
Minnesota Pollution Control Agency, 1973
Minnesota Pollution Control Agency, 1979
Minnesota Pollution Control Agency, 1981
Minnesota Power and Light, 1977
Minnesota State Board of Health, 1929
Minnesota State Board of Health, 1948
National Biocentrics, 1973a
National Biocentrics, 1973b
Sevener, 1978
United States Army Corps of Engineers, 1974
United States Army Corps of Engineers, 1975
United States Army Corps of Engineers, 1982
United States Environmental Protection Agency, 1975a
United States Environmental Protection Agency, 1977b
Weston, 1974a
Weston, 1974b
Weston, 1976
Winter, 1968
Wisconsin Department of Natural Resources, 1975

Birds

Davis and Erwin, in preparation
Davis et al, 1978
Harris and Matteson, 1975
Koch, 1981
Koch et al, 1980
Lounsbury et al, 1981
Magnuson et al, 1976
Niemi, 1978
Niemi et al, 1979a
Niemi et al, 1979b
Niemi et al, 1977
Peterson, 1979
Scharf, 1978
United States Army Corps of Engineers, 1975
Weston, 1974b

Fish

Cartier, 1968
DeVore, 1977
DeVore, 1978
DeVore and Hargis, 1982
Hassinger, 1967
Kaups, 1978
Koch et al, 1976
Minnesota Department of Natural Resources, 1980a
Minnesota Department of Natural Resources, 1980b
Minnesota Power and Light, 1966
Murray, 1980
National Biocentrics, 1973a
Peterson, 1979
Schram, 1978
Schram, 1982
Stepun, 1982
United States Army Corps of Engineers, 1974
United States Army Corps of Engineers, 1975
United States Department of Interior, 1968
Wechsler, 1980
Wisconsin Department of Natural Resources, 1968
Wisconsin Department of Natural Resources, 1969
Wisconsin Department of Natural Resources, 1976a
Wisconsin Department of Natural Resources, 1977a
Wisconsin Department of Natural Resources, 1982

Fish Contaminants

Doucette, 1980
Food and Drug, 1980
Helmke et al, 1976
Minnesota Department of Natural Resources, 1978
Minnesota Department of Public Health, 1982
Minnesota Pollution Control Agency, 1980
Moyle and Skrypeck, 1972
Sheffy and Aten, 1979
Sheffy et al, 1981
Skrypeck, 1973
Swain et al, 1975
United States Army Corps of Engineers, 1976
United States Environmental Protection Agency
Wisconsin Department of Natural Resources, 1979

Microbiology

City of Duluth, 1934
City of Duluth, 1946-1972
Dole and Wesbrook, 1907
International Joint Commission, 1977
Maschwitz et al, 1976
McElroy and Chin, 1974
Minnesota Department of Public Health, 1961
Minnesota Pollution Control Agency, 1969
Minnesota Pollution Control Agency, 1973

Microbiology (continued)

Minnesota Pollution Control Agency, 1977
Minnesota State Board of Health, 1929
Minnesota State Board of Health, 1948
National Biocentrics, 1973a
United States Army Corps of Engineers, 1974
United States Army Corps of Engineers, 1967
United States Environmental Protection Agency
Western Lake Superior Sanitary District, 1975a
Western Lake Superior Sanitary District, 1975b
Weston, 1974a
Weston, 1974b
Wisconsin Department of Natural Resources, 1972a
Wisconsin Department of Natural Resources, 1972b
Wisconsin Department of Natural Resources, 1975
Wisconsin Department of Natural Resources, 1977b
Wisconsin Department of Natural Resources, 1980

Physical Processes

American Bechtel, 1974
Bahnick, 1975
Bennett and Sydor, 1974
Chiu, and Woodall, 1974
Clapper et al, 1975
Horton et al, 1974
Jordan et al, 1981
Loy, 1963
National Biocentrics, 1973b
Quirk, Lawler, and Matusky, 1966
Stortz and Sydor, 1980
Sydor, 1974
Sydor, 1978
Sydor and Stortz, 1980
United States Army Corps of Engineers, 1982
United States Department of Interior, 1968
United States Environmental Protection Agency, 1977a
United States Environmental Protection Agency, 1977b
United States Geological Survey
Van Tassell and Moore, 1976
Weston, 1976

Phytoplankton

International Joint Commission, 1977
Kingston, 1982
Maschwitz et al, 1976
McElroy and Chin, 1974
Minnesota Department of Public Health, 1961
Minnesota Power and Light, 1977
Minnesota State Board of Health, 1948
National Biocentrics, 1973a
United States Army Corps of Engineers, 1974
United States Army Corps of Engineers, 1975
United States Environmental Protection Agency, 1975

Phytoplankton (continued)

United States Environmental Protection Agency, 1975b
United States Environmental Protection Agency, 1975c
Winter, 1968
Wisconsin Department of Natural Resources, 1977b

Sediment Chemistry

American Bechtel, 1974
Bahnick and Markee, in press
Bahnick et al, 1981
Helmke et al, 1976
Horton et al, 1974
Horton et al, 1976
International Joint Commission, 1977
Magnuson et al, 1976
Minnesota Pollution Control Agency, 1973
National Biocentrics, 1973a
National Biocentrics, 1973b
Prater and Anderson, 1976
Prater and Anderson, 1977
SERCO, 1982
Sheffy et al, 1981
Twin Cities Testing and Engineering Laboratory, Inc., 1973
United States Army Corps of Engineers, 1974
United States Army Corps of Engineers, 1975
United States Army Corps of Engineers, 1976
United States Army Corps of Engineers, 1977
United States Army Corps of Engineers, 1982
United States Environmental Protection Agency, 1975a
United States Environmental Protection Agency, 1977a
United States Environmental Protection Agency, 1977b
Van Tassell and Moore, 1976
Weston, 1974a
Weston, 1974b
Weston, 1976
Whiting, 1977
Wisconsin Department of Natural Resources, 1977b
Wisconsin Department of Natural Resources, 1980
Wisconsin Department of Natural Resources, 1982

Vegetation

Dabydeen and Koch, 1977
Davis and Erwin, in preparation
Davis et al, 1978
Koch et al, 1976
Koch, 1981
Lakela, 1939
Minnesota Department of Natural Resources, 1971
Minnesota Department of Natural Resources, 1980a
National Biocentrics, 1973a
Niemi et al, 1979a
Niemi et al, 1977
Peterson, 1979

Vegetation (continued)

Scharf, 1978
United States Army Corps of Engineers, 1974
United States Army Corps of Engineers, 1975
Weston, 1974a
Weston, 1974b

Water Quality

Bahnick, 1975
Bahnick et al, 1970
Bahnick and Markee, in press
Bahnick et al, in preparation
Bahnick et al, 1981
Bennett and Sydor, 1974
City of Duluth, 1934
City of Duluth, 1946-1972
Crosby, 1980
Dole and Wesbrook, 1907
Doucette, 1980
Hassinger, 1967
International Joint Commission, 1977
Long et al, 1978
McElroy and Chin, 1974
Chiu and Woodall, 1974
Minnesota Department of Natural Resources, 1971
Minnesota Department of Public Health, 1961
Minnesota Pollution Control Agency, 1969
Minnesota Pollution Control Agency, 1971
Minnesota Pollution Control Agency, 1973
Minnesota Pollution Control Agency, 1977
Minnesota Power and Light, 1977
Minnesota State Board of Health, 1929
Minnesota State Board of Health, 1948
National Bicentrics, 1973a
National Biocentrics, 1973b
National Biocentrics, 1973b
Northwest Paper Company, 1972
Peterson, 1979
Prater and Anderson, 1976
Prater and Anderson, 1977
Quirk, Lawler and Matusky, 1977
Schraufnagel et al, 1966
Sevener, 1978
Stepun, 1982
Stortz and Sydor, 1980
Swain et al, 1975
Sydor and Stortz, 1980
United States Army Corps of Engineers, 1974
United States Army Corps of Engineers, 1975
United States Army Corps of Engineers, 1976
United States Department of Interior, 1967
United States Department of Interior, 1968
United States Environmental Protection Agency
United States Environmental Protection Agency, 1975b
United States Environmental Protection Agency, 1975c

Water Quality (continued)

Wechsler, 1980
Western Lake Superior Sanitary District, 1975a
Western Lake Superior Sanitary District, 1975b
Weston, 1974a
Weston, 1974b
Winter, 1968
Wisconsin Department of Natural Resources, 1972a
Wisconsin Department of Natural Resources, 1972b
Wisconsin Department of Natural Resources, 1975
Wisconsin Department of Natural Resources, 1976b
Wisconsin Department of Natural Resources, 1977b

Zooplankton

International Joint Commission, 1977
Maschwitz et al, 1976
Minnesota Power and Light, 1977
National Biocentrics, 1973a
United States Army Corps of Engineers, 1974
United States Army Corps of Engineers, 1975
Winter, 1968